MORRIS GRIFFITH
ASSISTANT OFFICE ENGINEER

MONTANA
STATE HIGHWAY COMMISSION

Standard Specifications
for
Road and Bridge Construction
Including Contract and Bond

ADOPTED JULY, 1931
REVISED OCTOBER, 1932
REVISED FEBRUARY, 1934
REVISED APRIL, 1935
HELENA, MONTANA

THURBER'S, HELENA

CONVERSION TABLE

QUANTITIES PER LINEAR FOOT OF REINFORCED CONCRETE PIPE

Size	Total Weight	Cement Pounds	Cement Barrels	Aggregate Pounds	Aggregate Cu.Yd.	Re-Steel Pounds
			Standard Pipe			
12"	92 Lb.	14	0.03723	76.4	0.02680	1.6
15"	127 "	19	0.05053	105.7	0.03708	2.3
18"	168 "	25	0.06648	139.8	0.04905	3.2
24"	265 "	40	0.10638	219.2	0.07691	5.8
30"	384 "	58	0.15425	312.0	0.10947	14.0
36"	524 "	79	0.21010	426.5	0.14964	18.5
42"	686 "	103	0.27393	558.4	0.19592	24.6
48"	870 "	131	0.34840	707.4	0.24821	31.6
			Extra Strength Pipe			
24"	265 Lb.	43	0.11436	214.0	0.07508	8.0
30"	384 "	62	0.16489	304.0	0.10666	18.0
36"	524 "	84	0.22340	414.3	0.14536	25.7
42"	686 "	110	0.29255	541.7	0.19007	34.3
48"	870 "	140	0.37234	685.6	0.24056	44.4

Data furnished by Elk River Concrete Products Co.

WEIGHTS OF CORRUGATED METAL PIPE

Size	Gauge	Weight Lbs. Per Foot
12"	16	10.5
15"	16	12.9
18"	16	15.3
24"	14	25.2
30"	14	30.9
36"	12	51.0
42"	12	59.5
48"	12	68.0
60"	10	108.9

MISCELLANEOUS ITEMS

Item	Cement Barrels	Aggregate Cu.Yd.	Sand Cu.Yd.	Re-Steel Pounds
Concrete Project Marker	0.091	0.064	-	6.523
Concrete Right of Way Monument	0.023	0.015	-	1.070
Grouted Riprap	0.054	-	0.023	-

LUMBER

Item	M. F. B. M.
Wood Guide Posts	0.032 M.F.B.M. per post
Laminated Wood Guard Rail	0.0094 M.F.B.M. per lin.ft. + 0.032 MFBM for 1 post /
Wood Station Markers	0.0053 M.F.B.M. per marker
Wood Slat Snow Fence	0.0012 M.F.B.M. per lin.ft. including stiffener

Steel Posts for Snow Fence - 9.333 lb. per post (Space 9' - 10')
Weight of Wire per Linear Foot of Snow Fence - .53 lb. + .4 lb. for end guy.
Weight of Hardware per Lin. Foot of Guard Rail - 0.5 lb.

PR 47

FEDERAL WORKS AGENCY
PUBLIC ROADS ADMINISTRATION

Statement of Materials and Employment
(To Accompany Final Inspection Report)

Date Started_____ State_____

Date Completed_____ Project No._____

Materials Purchased for Roadway

Total Cost Roadway $_____ Length: Miles_____

Code	Material Item	Unit	Quantity	Code	Material Item	Unit	Quantity
1	Cement	Bbl.		6	Metal culvert pipe	Lb.	
2	Aggregates	Cy.		7	Reinforcing steel	Lb.	
3	Bituminous mat.	Gal.		8	Structural steel	Lb.	
4	Lumber	M.		9	Petroleum prod.	Gal.	
5	Timber piling	Lft.		10	Explosives	Lb.	

Materials Purchased for Bridges over 20 Ft. Span

No. of Bridges_____ Total Cost Bridges $_____ Length: Miles_____

Code	Material Item	Unit	Quantity	Code	Material Item	Unit	Quantity
1	Cement	Bbl.		6	Metal culvert pipe	Lb.	
2	Aggregates	Cy.		7	Reinforcing steel	Lb.	
3	Bituminous mat.	Gal.		8	Structural steel	Lb.	
4	Lumber	M.		9	Petroleum prod.	Gal.	
5	Timber piling	Lft.		10	Explosives	Lb.	

Employment

Classification of Labor	Total Employment as Reported Payrolls and Form Emp. 200	
	Man-Hours (nearest man-hour)	Wages Paid (nearest dollar)
1. Executive, Administrative and Supervisory		
2. Skilled		
3. Intermediate Grade		
4. Unskilled		
Total		

INSTRUCTIONS

For Preparing Form PR 47

1. All information except that for starting and completion dates, project costs, and mileage will be supplied to the resident engineers by the contractor, as required by the special provisions for Federal-aid projects. The quantities of each material are to be reported only in the units shown and divided by roadway and bridges. Employment data shall correspond to the accumulated totals of the payroll forms.

2. A separate form may be submitted for each subcontractor, but all forms for a single project (or a combination of projects in one contract) must be submitted to the District Engineer together. Forms for the force account work should be submitted at the same time.

3. Before forwarding these forms to Washington, the District Engineer shall enter the starting and completion dates which shall be in agreement with records kept in the District Office. The total cost of the project shall be recorded to the nearest thousand dollars on the form PR 47 submitted for the main contract only. This figure shall include the contract cost, force account items, and the engineering and contingencies items. It shall be the best figure available to the District Engineer at the time. If there are bridges over 20 feet long on the project, the total cost shall be divided between roadway and bridges. The District Engineer shall record the mileage of the project only on the form for the main contract, and shall be to the nearest thousandth of a mile.

STATE HIGHWAY COMMISSION
Helena, Montana

AVERAGE UNIT CONTRACT PRICES FOR 1940

Item	Total Quantity	Total Cost	Average Unit Price	Unit
ROADWAY ITEMS				
Unclassified Excavation	7,665,239	$1,476,889.86	$ .19	Cu. Yd.
Select Borrow Material	198,952	45,998.59	.22	" "
Culvert Excavation	42,308	44,009.30	1.04	" "
Overhaul	8,997,070	88,572.75	.0100	Sta. Yd.
Overhaul	626,898	86,982.65	.14	Mi. Yd.
Hand Laid Rip Rap	2,708	14,665.10	5.42	Cu. Yd.
Random Rip Rap	16,929	46,286.59	2.84	" "
Grouted Rip Rap	14,015	44,474.55	3.17	Sq. Yd.
8" Perforated Metal Underdrain	541	816.00	1.50	Lin. Ft.
10" Corrugated Metal Pipe (Perforated)	90	180.00	2.00	" "
12" " " " Culvert	2,084	13,445.80	1.69	" "
15" " " " "	4,698	9,728.10	2.07	" "
18" " " " "	28,260	77,796.00	2.54	" "
21" " " (Perforated)	100	280.00	2.80	" "
21" " " 12 Ga.	340	1,917.60	5.64	" "
24" " " Culvert	1,864	7,646.40	4.10	" "
30" " " " "	5,706	32,135.70	5.63	" "
36" " " 10 Ga.	144	1,008.00	7.00	" "
42" " " Culvert	84	588.00	7.00	" "
48" " " " "	2,766	21,564.00	7.80	" "
48" " " 10 Ga.	108	869.40	8.05	" "
57" " " Culvert	144	1,888.00	13.11	" "
15" " Syphon Pipe	440	1,115.00	2.50	" "
18" " " "	2,690	8,772.00	3.26	" "
24" " " "	6,346	27,667.50	4.23	" "
30" " " "	1,448	7,453.60	5.15	" "
36" " " "	1,452	9,997.60	6.89	" "
48" " " "	232	3,120.00	13.45	" "
105" Sectional Plate Corr. Metal Pipe Culvert	70	3,150.00	45.00	" "
1.00" " " " "	105	5,775.00	55.00	" "
1.35" " " " "	125	6,375.00	51.00	" "
Relaying Corr. Metal Pipe Culvert	2,233	2,598.90	1.16	" "
Gravel Backfill	319	510.40	1.60	Cu. Yd.
12" Reinforced Concrete Pipe Culvert	5,944	12,790.20	2.15	Lin. Ft.
18" " " " "	1,154	3,907.60	3.37	" "
24" " " " "	15,892	62,413.60	3.93	" "
30" " " " "	848	4,967.80	5.86	" "
36" " " Culvert	620	4,496.00	5.48	" "
36" " " Ext. Str.	348	1,879.20	5.40	" "
42" " " Culvert	3,844	22,508.00	6.68	" "
42" " " Ext. Str.	208	1,487.20	7.15	" "
48" " " Culvert	288	2,155.20	7.48	Lin. Ft.
48" " " " "	3,594	40,648.20	11.30	" "
Relaying Reinforced Concrete Pipe Culvert	343	634.50	1.85	" "
6" Black Iron Pipe	140	280.00	2.00	" "
8" Cast Iron Water Pipe	344	688.00	2.00	" "
10" Smooth Black Metal Pipe	350	700.00	2.00	" "
Class A Concrete	326.01	9,116.77	29.76	Cu. Yd.
Class B Concrete	67.41	2,618.44	32.59	" "
Reinforcing Steel	20,021	1,580.63	.0789	Lb.
Sand Surfacing	26,878	21,502.00	.80	Cu. Yd.
Sand Subbase	43,375	28,392.99	.66	" "
Crushed Gravel Base Course	24,174	18,130.50	.75	" "
Earth Cushion Material	3,969	4,150.70	.30	" "
Base Course Crushed Gravel	1,363,574	820,400.64	.60	Ton
Crushed Gravel Surfacing	281,511	171,167.36	.61	"
Grade "A" Top Course Crushed Gravel	491,546	400,528.06	.82	"
Grade "B" " " " "	45,457	31,770.61	.70	"
Stock Piles Gravel	28,405	21,692.80	.77	"
Stone Chips	46,181	158,835.46	3.43	"
Stock Piles Crushed Rock	5,000	9,950.00	1.99	Cu. Yd.
Binder	91,000	9,334.00	.10	" "
Overhead on binder	183,000	14,037.00	.08	Yd. Mi.
Watering	79,735	112,125.50	1.41	M. Gal.
Rolling	13,069	50,238.50	3.60	Hr.
Fine Grading	29,745	6,751.80	226.99	Mile
Blading if Subgrade	1,150	5,435.00	4.73	Hr.
S-1 Asphaltic Road Oil	11,325	872.03	.077	Gal.
SC-2 " " " "	168,683	14,619.32	.0699	"
SC-4 " " " "	1,464,005	114,164.26	.0784	"
SS-1 " " " "	878,763	86,061.67	.0979	"
MC-2 Harmons Cutback Asphalt	44,210	9,860.00	.1847	"
MC-3 " " " "	1,910,975	185,012.87	.0968	"
Seal Coat Oiling (RC-1 Road Oil)	44,014	4,423.74	.1007	"
Emulsified Asphalt Processing	374,634	34,407.05	.1180	"
Processing 20' Roadway	95,447	2,998.05	.15	Sq. Yd.
" 24' "	70,135	55,150.98	786.20	Mile
" 32' "	70,135	73,374.37	1046.19	"
" 40' "	0.271	871.00	3200.00	"
" 68' "	0.193	312.66	1620.00	"
" Emulsified Asphalt Base	5.947	12,279.07	2125.00	"
" Stabilized Base	5.993	11,524.70	1900.00	"
" Road Approaches	16,366	4,747.65	.29	Sq. Yd.
Oil Treated Gravel Footpath	76	26.60	.35	Lin. Ft.
Clearing	1,479	20,118.00	13.62	Half Sta.
Grubbing	1,044	12,461.10	11.95	" "
Advance Warning Signs	4	320.00	43.34	Each
Reflector R.R. Crossing Signs	4	400.00	100.00	"
Concrete Project Markers	73	1,109.00	15.19	"
Wood Station Markers	1,782	5,404.79	3.03	"

Item	Total Quantity	Total Cost	Average Unit Price	Unit
Concrete Right of way Monuments	3,513	15,086.20	4.30	Each
Wood Guide Posts	603	1,707.50	2.83	"
Laminated Wood Guard Rail	15,104	17,005.40	1.16	Lin. Ft.
Lumber in Headgates	1,444	620.00	42.00	M.F.B.M.
Wood Blat Snow Fence	35,250	8,102.50	.23	Lin. Ft.
1½" Galvanized Water Pipe	60	45.00	.75	" "
2" Galvanized Water Pipe	420	252.00	.60	" "
36" Metal Headgate	1	150.00	150.00	Each
Comb. Wood Guard Rail & Header	2,052	3,707.60	1.80	Lin. Ft.
48 Metal Ditch Lining	50	50.00	1.00	" "
Gutter Drain Inlets	2	100.00	50.00	Each
BRIDGE ITEMS				
Treated Lumber	2899.09	240,248.38	104.50	M.F.B.M.
Untreated Lumber	1284.74	12,644.60	101.37	M.F.B.M.
15' Treated Timber Piles	9	135.00	15.00	Each
20' " " "	492	10,837.00	22.02	"
25' " " "	69	1,646.00	23.89	"
28' " " "	30	840.00	28.00	"
30' " " "	592	16,941.00	28.15	"
35' " " "	249	8,221.40	33.03	"
40' " " "	123	7,676.60	34.43	"
45' " " "	234	8,662.20	37.55	"
50' " " "	71	3,268.00	45.64	"
55' " " "	26	1,420.00	54.71	"
60' " " "	15	870.00	58.00	"
Treated Foundation Piling	3,480	3,132.00	.90	Lin. Ft.
Gravel Ballast	708	1,737.00	2.45	Cu. Ft.
Structural Steel	671,955	49,541.18	.073	Lb.
Cast Steel	23,662	4,384.11	.185	"
Carbon Steel	604,600	18,352.00	.03	"
Silicon Steel	204,900	21,352.00	.10	"
Reinforcing Steel	344,100	34,409.45	.0999	"
Class A Concrete	2,219	52,634.00	23.72	Cu. Yd.
Class B Concrete	1307.14	42,732.30	26.98	" "
Class X Concrete	6	240.00	40.00	" "
Structure Excavation	4,290	14,941.50	3.49	" "
Concrete Curb & Rail	571.84	2,332.49	4.08	Lin. Ft.
Concrete Handrail	566	1,698.00	3.00	" "
Steel Handrail	1,211	3,633.00	3.00	" "
Cast Iron Drains	36	324.00	9.00	Each
Steel Bearing Piles	61,200	3,982.68	.0651	Lb.
Driving Steel Bearing Piles	1,344	750.00	.56	Lin. Ft.
Pile Load Tests	2	500.00	250.00	Each
ROADSIDE IMPROVEMENT ITEMS				
Rounding Cut Slopes	59,707	5,575.16	.093	Lin. Ft.
Stone Curb	100	125.00	1.25	" "
Stone Barrier	1,362	932.30	.69	" "
Log Curb	610	610.00	1.00	" "
Flagstone Paving	36	28.00	.78	Sq. Yd.
Flagstone Step	50	90.00	1.80	"
Entrance Markers	1	75.00	75.00	Each
Roadside Markers	6	150.00	25.00	"
Stone Wall	34	340.00	10.00	Cu. Yd.
6" Drilled Well	100	300.00	3.00	Lin. Ft.
Pressure Water System	1	500.00	500.00	Each
Septic Tank & Distribution Box	1	150.00	150.00	"
1" Galvanized Water Pipe	435	114.25	.26	Lin. Ft.
1½" " " "	700	140.00	.20	" "
3/4" " " "	135	32.40	.24	" "
Gravel Footpath	266	266.00	1.00	Sq. Yd.
Stone fountain	3	575.00	191.67	Each
Cusp Tables	4	100.00	25.00	"
Log Post Signs	2	60.00	30.00	"
Garbage Disposal Units	3	30.00	10.00	"
Directional Signs	6	60.00	10.00	"
Log Seat	2	45.00	22.50	"
Water System Control Box	1	75.00	75.00	"
Valve Box	1	15.00	15.00	"
Latrines	4	400.00	100.00	"
Pilot Signs	2	80.00	40.00	"
Overlook Shelter	1	1000.00	1000.00	"
Pump & Toilet Building	1	500.00	500.00	"
Screened Gravel	610	1,415.00	2.32	Cu. Yd.
Top Soil	30	30.00	1.00	" "
Woven Wire Fence	42	217.00	5.10	Rod
Native Sod	250	250.00	1.00	Sq. Yd.
Canadian Poplar Trees	163	1,114.10	7.02	Each
Native Cottonwood Trees	9	22.50	2.50	"
Green Ash Trees	31	93.00	3.00	"
Native Elm Trees	4	20.00	5.00	"
Bale of Oilseed Trees	10	90.00	9.00	"
Northwest Poplar Trees	9	153.00	17.00	"
Russian Willow Trees	30	30.00	1.00	"
Juniper Prostrate Shrubs	33	165.00	5.00	"
Juniper Pyramidal Shrubs	23	117.23	5.17	"
Choke Cherry Shrubs	126	126.00	1.00	"
Buffalo Berry Shrubs	16	16.00	1.00	"
Lilac Shrubs	96	72.00	.75	"
Russian Olive Shrubs	253	253.00	1.00	"
Caragana Shrubs	173	214.40	1.24	"
Planted Snow Fence	850	340.00	.40	Lin. Ft.
Fairway Crested Wheat Grass Seed	24	22.00	1.00	Lb.

STATE HIGHWAY COMMISSION

Helena, Montana

Aug. 1, 1936

CORRECTIONS, REVISIONS AND ADDENDA TO STANDARD SPECIFICATIONS AS REVISED APRIL, 1935

The following corrections, revisions and addenda to the standard specifications for road and bridge construction, revised April, 1935, shall be effective immediately.

Article 3.4, Page 4.

All that portion of Article 3.4, Page 4, of the Standard Specifications, beginning with and following the words, "and attached thereto," in the fifth line shall be cancelled. The article will then read as follows:

"3.4. CONTRACT BOND REQUIRED. The successful bidder, at the time of the execution of the Contract, must deposit, with the Commission, a surety bond for the full amount of the contract. The form of bond shall be that provided by the Commission and the surety shall be acceptable to the Commission. The surety bond must be executed by a surety company authorized by law to transact such business in the State of Montana."

Article 19.2, Page 26.

Article 19.2, Page 26, of the Standard Specifications shall be superseded by the following specifications:

19.2. MATERIAL. The material shall consist of a hard, durable gravel uniformly graded between the following limits:

Passing a screen with 3½-inch square openings	100%
Passing a screen with 3-inch square openings	95%
Passing a 4-mesh sieve	25 to 50%
Passing a 200-mesh sieve, not more than	15%

Article 22.2, Page 29.

The following specifications covering "water-asphalt preferential" and "swell" shall be added to the specifications for Grade "A" top course crushed rock or crushed gravel surfacing material:

Water-asphalt preferential—When subjected to the "water-asphalt preferential test" described below, the material passing a 200-mesh sieve shall show a separation of not more than 25%.

Water-asphalt preferential test method: This test is designed to determine the relative affinity of the filler material for water and asphalt. The test is performed by mixing fifty (50) cubic centimeters of SC-2 liquid asphalt and ten (10) grams of the filler material passing a 200-mesh sieve, at a temperature of one hundred forty degrees (140°) F. After the filler and oil are thoroughly mixed, one hundred (100) cubic centimeters of distilled water at a temperature of one hundred forty degrees (140°) F. is added. The mixture is stirred for five (5) minutes by an electrical stirrer, and then permitted to stand until precipitation has ceased. The precipitated filler is then dried and weighed, the separation being this weight in grams multiplied by ten (10).

Swell test—When subjected to the following swell test, the total mineral aggregate shall not show a greater swell than that shown in the following table:

SURFACE AREA OF AGGREGATE—SQ. FT.	TENTATIVE PERMISSIBLE SWELL—INCHES
20	0.020
30	0.025
40	0.030
50	0.035
60	0.040
70	0.045
80	0.050
90	0.055
100 and over	0.060

Swell test method: This test is designed to measure the quality of an aggregate which causes a bituminous surfacing to become soft and disintegrate in wet weather. The mineral aggregate is mixed with SC-2 grade liquid asphalt and compacted by tamping in a metal cylinder four inches (4″) in diameter and at least five inches (5″) high. Sufficient aggregate is used to form a compacted briquette two inches (2″) high. The surface of the briquette is then covered with water to a depth of two and one-half inches (2½″) and any resulting swell measured after the lapse of twenty-four (24) hours. The vertical expansion or swell is measured accurately to the nearest one-thousandths of an inch (0.001″).

The last paragraph on Page 29 shall be superseded by the following:

"The fine aggregate (that passing a ¼-inch screen) in Grade "B" surfacing material may contain such a quantity of material passing a 200-mesh sieve that the percentage in the entire mass of surfacing material shall not exceed 15 per cent."

Article 23.2, Page 32.

Change the number of the last Article on Page 32 from "23.3" to "23.2."

Article 26.3, Page 40.

The first paragraph of this article shall be superseded by the following:

"The Contractor shall put into each batch the designated number of bags of cement and the amount of water, and weigh into each batch the respective weights of fine and coarse aggregates designated by the Engineer for the particular job materials and class of concrete being used; except that, on structures involving less than 50 cubic yards, the Engineer may, at his discretion, permit the Contractor to proportion the aggregates by volume."

Article 26.4 (d), Page 42.

The last four paragraphs on Page 42 shall be superseded by the following:

"Coarse aggregate shall be well graded, between the limits specified and the size or sizes designated shall conform to the following requirements when tested by means of laboratory screens:

Designated sizes	Percentage by weight passing laboratory sieves having square openings, in inches							
	2½	2	1½	1	¾	½	⅜	No. 4
No. 4 to ½ in.					100	90–100		0–15*
No. 4 to ¾ in.				100	90–100		20–55	0–10
No. 4 to 1-in.			100	90–100		25–60		0–10
No. 4 to 1½ in.		100	95–100		35–70		10–30	0–5
No. 4 to 2 in.	100	95–100		35–70		10–30		0–5
¾-in. to 1½ in.		100	90–100	20–55	0–15			
1-in. to 2-in.	100	90–100	35–70	0–15				

* Not more than 5 per cent shall pass a No. 8 sieve.

[illegible]

(Attention is called to the fact that the shape of aperture specified for determining compliance with specifications for size of coarse aggregate has no relation to the size or shape of aperture or type of screen used in the production of the material.)

The size of the coarse aggregate for the various classes of concrete with reference to the preceding table of grading requirements shall be as follows:

Class	Designated Sizes
A	No. 4 to 1½-in.
S	No. 4 to 1½-in.
B	No. 4 to 2-in.
D, in handrails	No. 4 to ½-in.
D, all others	No. 4 to 1-in.

Article 27.1, Page 52.

Delete the words "or expanded metal" from the second line of this Article and the words "and expanded metal" from the fifth and sixth lines.

Article 27.2, Page 53.

The last paragraph of Article 27.2 on Page 53 shall be superseded by the following:

"Steel mesh shall be manufactured from material fulfilling the requirements of the standard specifications of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society, for cold drawn steel wire for concrete reinforcement, A. S. T. M. Designation A 82-34."

Article 27.5, Page 53.

In the last paragraph on Page 53 add the word "or" before the word "steel" and delete the words "or expanded metal."

Article 35.3 (e), Page 73.

The words "Douglas Fir" shall be transposed to a position above the words "Southern Yellow" in the tabulation near the center of Page 73.

Article 35.4 (a), Page 75.

The last paragraph of this Article shall be superseded by the following:

"For general construction, piles shall be treated to retain not less than eight (8) pounds of the preservative per cubic foot by any standard empty cell process using either grade 1 or 2 creosote oil."

Article 37.3, Page 83.

In the tabulation at the bottom of Page 83, change the minimum gauge for 24 inch pipe from 16 to 14 gauge.

Article 49.2, Page 93.

The second sentence of Article 49.2, Page 93 shall be superseded by the following:

"The base metal shall comply with the physical and chemical requirements as specified in Section 37 for culvert pipe; the spelter coating of the sheets, however, shall be Class C (1.75 oz. per sq. ft.) complying with the provisions for this class of spelter coating as set forth in Sections 4 and 5 (b) of the standard specifications for zinc coated (galvanized) sheets of the American Society for Testing Materials, A. S. T. M. Designation: A 93-27."

MONTANA INCORPORATED CITIES AND TOWNS

Town	Alberton	276
City	Anaconda	12494
Town	Bainville	471
City	Baker	1212
Town	Bearcreek	472
Town	Belgrade	533
Town	Belt	810
Town	Big Sandy	633
City	Big Timber	1224
City	Billings	16380
Town	Boulder	926
City	Bozeman	6855
Town	Bridger	567
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STATE OF MONTANA

State Highway Commission

Standard Specifications
for
Highway Construction

DIVISION 1
GENERAL PROVISIONS

ADOPTED JULY, 1931
REVISED OCTOBER, 1932
REVISED FEBRUARY, 1934
REVISED APRIL, 1935
HELENA, MONTANA

SECTION 1

DEFINITIONS AND TERMS.

Whenever in these specifications and contract the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

1.1 "State".....The State of Montana.

1.2 "Commission".....State Highway Commission of Montana.

1.3 "Engineer".....The State Highway Engineer, acting directly or through an assistant or other representative duly authorized by the State Highway Commission, such assistant or representative acting within the scope of the particular duties assigned to him, or of the authority given him.

1.4 "Inspector".....An authorized representative of the Engineer, assigned to make any or all necessary inspections of the work performed and materials furnished by the Contractor.

1.5 "Laboratory".....The official testing laboratory of the Commission at Helena, acting through the Engineer.

1.6 "Bidder".....Any individual, firm, or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.

1.7 "Contractor".....Party of the second part to the contract, acting directly or through his agents or employees.

1.8 "Surety".....The corporate body which is bound with and for the Contractor, who is primary liable, and which engages to be responsible for his payment of all debts pertaining to and for his acceptable performance of the work for which he has contracted.

1.9 "Proposal".....The approved prepared form on which the Bidder is to submit or has submitted his, their, or its proposal for the work contemplated.

1.10 "Proposal Guaranty" The security designated in the proposal, to be furnished by the Bidder as a guaranty of good faith to enter into a contract with the State, if the work of constructing the improvement is awarded to him.

1.11 "Plans".....All drawings, or reproductions of drawings, pertaining to the construction of the improvement.

1.12 "Specifications".....The directions, provisions, and requirements contained herein, together with all written agreements made or to be made, pertaining to the method and manner of performing the work, or to the quantities and qualities of materials to be furnished under the contract.

1.13 "Contract".....The agreement covering the performance of the work, and the furnishing of materials in the construction of same. The contract shall include the accepted "Proposal," "Plans," "Specifications" and "Contract Bond," also any and all supplemental agreements which reasonably could be required to complete the construction of the work in a substantial and acceptable manner.

1.14 "Contract Bond".....The approved form of security furnished by the Contractor and his Surety as a guaranty of good faith on the part of the Contractor to execute the work in accordance with the terms of the contract.

1.15 "Highway".....The whole right-of-way which is reserved for use in constructing the roadway and its appurtenances.

1.16 "Roadway".....That portion of the highway included between the gutter or side ditch lines, reserved for the accommodation of the traveling public, and its appertaining structures and slopes, and all ditches, channels, waterways, bridges, etc., necessary to its correct drainage.

1.17 In order to avoid cumbersome and confusing repetition of expressions in these specifications, whenever it is provided that anything is, or is to be, or to be done, if, or as, or when, or where "contemplated," "required," "directed," "specified," "authorized," "ordered," "given," "designated," "indicated," "considered necessary," "deemed necessary," "permitted," "suspended," "approved," "acceptable," "unacceptable," "suitable," "unsuitable," "satisfactory," "unsatisfactory," or "sufficient," it shall be understood as if the expression were followed by the words "by or to the Engineer with the approval of the Commission."

1.18 It should be understood thoroughly by all concerned that all things contained herein, together with the "Advertisement for Proposals" or "Notice to Contractors," and the "Contract Bond," as well as any papers attached to or bound with any of the above, also any and all supplemental agreements made or to be made, are hereby made a part of these Specifications and Contract, and are to be considered one instrument. No papers attached to or bound with any of the above shall be detached therefrom as all are a necessary part thereof.

SECTION 2.

PROPOSAL REQUIREMENTS AND CONDITIONS.

2.1 Contents of Proposal Forms. The Bidder will be furnished with a proposal form which will state the location and description of the contemplated work, and which will show the approximate estimate of the various quantities of the work to be performed and the materials to be furnished, the amount of "Proposal Guaranty" (which must accompany the proposal) and the date and time of the opening of proposals. It will also state any special provisions or requirements which vary from or are not contained in the Standard Specifications. All papers bound with or attached to the proposal form are a necessary part thereof and must not be detached.

2.2 Interpretation of Estimate. The quantities scheduled in the proposal forms are to be considered as approximate and as prepared for the comparison of bids only. The unit prices to be tendered by the bidder are to be tendered expressly for the scheduled quantities as they may be increased or decreased within the restricting percentage hereinafter stipulated. Payment to the Contractor will be made for the actual quantities only of work performed or materials furnished in accordance with the contract, and it is understood that the scheduled quantities of work to be done and materials to be furnished may each be increased or diminished as hereinafter provided without in any way invalidating the bid prices.

2.3 Examination of Plans, Specifications, Special Provisions and Site of Work. The bidder is required to examine carefully the site of, and the proposal, plans, specifications and contract forms for the work contemplated; it will be assumed that the bidder has investigated and is satisfied as to the conditions to be encountered for performing the work as scheduled or as at any time altered without resulting in increases or decreases of more than the restricting percentage hereinafter stipulated, and as to the character, quality and quantities of work to be performed and materials to be furnished, including increases and decreases, and as to the requirements of these specifications, special provisions, and contract. It is mutually agreed that submission of a proposal shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to all the conditions and contingencies.

2.4 Preparation of Proposal. The bidder must submit his proposal on the form furnished by the Commission. The blank spaces in the form must be filled in correctly for each and every item for which a quantity is given, and the bidder must state the prices (written in ink, both in words and numerals) for which he proposed to do each item of work contemplated. All proposals must be extended and totaled. The bidder must sign his proposal correctly, showing his name and postoffice address. If the proposal is submitted by a firm or partnership, the name and postoffice address of each member of the firm or partnership must be shown; if submitted by a corporation, the name of the State under the laws of which the corporation was chartered, and the names, titles and business addresses of the President and Secretary must appear.

2.5 Rejection of Proposals Containing Alterations, Erasures or Irregularities. Proposals may be rejected if they show any omissions, erasures, alteration of form, additions not called for, unauthorized conditional or alternate bids, or irregularities of any kind.

2.6 Proposal Guaranty. No proposal will be considered unless accompanied by a "Proposal Guaranty" of the character and amount indicated in the proposal form, made payable to the State Highway Commission.

2.7 Delivery of Proposals. Each proposal must be submitted in a special envelope furnished by the Commission. The blank spaces on the envelope must be filled in correctly so as to indicate its contents clearly. If forwarded by mail, the above-mentioned envelope shall be enclosed in another addressed to the State Highway Commission at Helena, Montana; if forwarded otherwise than by mail it shall be delivered at the office of the State Highway Commission in Helena, Montana. Proposals will be received until the time stipulated in the advertisement for the opening thereof.

2.8 Withdrawal of Proposals. Bidders may withdraw any proposal after it has been deposited with the Commission, provided the Bidder makes his request in writing to the Commission prior to the time set for opening the proposals; and at the time of the opening of the proposals when such proposal is reached, it will be returned to the Bidder unread.

2.9 Public Opening of Proposals. Proposals will be opened publicly and read at the time and on the date set in the "Advertisement for Proposals" or "Notice to Contractors," in the office of the State Highway Commission in Helena. Bidders or their authorized agents are invited to be present.

2.10 Disqualification of Bidders. More than one proposal from an individual, a firm or partnership, a corporation or an association under the same or different names will not be considered. Reasonable grounds for believing that any bidder is interested in more than one proposal for the work contemplated will cause the rejection of all proposals in which such bidder is interested. Any or all proposals will be rejected if there is reason for believing that collusion exists among the bidders and all participants in such collusion will not be considered in future proposals for the same work. Proposals in which the prices obviously are unbalanced will be rejected.

2.11 Competency of Bidders. No contract will be awarded except to responsible bidders capable of performing the class of work contemplated. Each bidder shall furnish, on a standard form furnished by the Commission, a complete statement of his experience and of the amount of capital and equipment available for the proposed work. The standard form must be correctly and completely filled out and sworn to, and must be submitted to the Commission sufficiently in advance of the opening of bids to allow them to pass upon the qualifications of the bidder prior to the opening of bids. It will be considered an essential part of the bid, and failure to submit the statement prior to the time specified by the Commission may be deemed sufficient cause for rejection of the bid without reading it.

2.12 Material Guaranty. Before any contract is awarded the bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the improvement, together with samples, which samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

SECTION 3.

AWARD AND EXECUTION OF CONTRACT.

3.1 Consideration of Bids. The comparison of bids will be based on the correct extension and summation of all items included in the proposal at prices bid. Provided, however, that the Commission reserves the right to reject any or all proposals, or to waive technicalities as may be deemed best for the interest of the State.

3.2 Award of Contract. All contracts will be awarded by the Commission at Helena, to the lowest responsible bidder, within forty-five (45) days from the date of the opening of the proposals; provided, however:

3.3 Return of Proposal Guaranty. All "Proposal Guaranties" except those of the three (3) lowest bidders will be returned within three (3) days following the date of opening bids. Should no award be made within forty-five (45) days, all proposals will be rejected and all guaranties returned.

3.4 Contract Bond Required. The successful bidder, at the time of the execution of the Contract, must deposit, with the Commission, a surety bond for the full amount of the contract. The form of bond shall be that provided by the Commission and the surety shall be acceptable to the Commission. The surety bond must be executed by a surety company authorized by law to transact such business in the State of Montana and attached thereto must be a certificate under the seal of said surety company that a full local agent's commission will be paid by said surety company to a licensed Montana agent of said surety company and that full credit for said bond and bond premiums has been entered upon the books of the Montana Branch office or Montana General Agency of said surety company, providing said surety company maintains such Branch Office or General Agency.

3.5 Execution of Contract. The individual, firm, or corporation to whom or to which the contract has been awarded shall enter into a contract with the State within ten (10) days after the award. No proposal shall be considered binding upon the State until the execution of the contract.

The contract shall be signed by each member of the firm or partnership, where the award is to a firm or partnership, and by a duly authorized Representative and have the corporate seal of the corporation attached, if the award is to a corporation.

3.6 Approval of Contract and Bond. The contract shall be approved by the Attorney General of Montana, after execution by the Contractor and by the Chairman of the Commission. The bond shall likewise be approved after execution by the Contractor and Surety.

3.7 Failure to Execute Contract. Failure to execute the Contract or give satisfactory security, as specified, shall be just cause for annulment of the award, or of the Contract if executed, and in the event of the annulment of the award, or of the Contract, the Proposal Guaranty shall be forfeited to the State, not as a penalty, but as liquidated damages.

SECTION 4.
SCOPE OF WORK.

4.1 Intent of Plans and Specifications. The Contractor shall do all clearing and grubbing, make all excavations and embankments, do all shaping and surfacing, construct all ditches, drainage structures, bridges, and other appertaining structures, as indicated in the proposal and on the plans; remove obstructions from within the lines of the highway and shall do such additional, extra and incidental work as may be considered necessary to complete the roadway to the proper lines, grades and cross-sections, in a substantial and workmanlike manner. He shall furnish, unless otherwise provided, all implements, machinery, equipment, tools, material and labor necessary to the prosecution of the work. In short, the Contractor shall construct the improvement in strict accordance with the plans, specifications, special provisions, and contract, and when completed, shall leave it in a neat and finished condition.

4.2 Special Work. Should any construction or conditions which are not covered by the standard specifications be anticipated on any proposed work "special provisions" for such work will be stated on or attached to the proposal form and shall be considered a part of these specifications the same as though contained fully herein. Should any such special provisions or requirements conflict with these specifications, the "special provisions" shall govern.

4.3 Increased or Decreased Quantities. The Engineer reserves the right to make such alterations in the plans or in the quantities of work as may be considered necessary. Such alterations shall be in writing and shall not be considered as a waiver of any conditions of the contract nor to invalidate any of the provisions thereof, provided that no alteration shall involve an extension or shortening of the length of the project of more than 25 per cent, and provided that a supplemental agreement with the Contractor will be necessary when alterations involve (1) an increase or decrease of more than 25 per cent of the total cost of the work calculated from the original proposal quantities and the contract unit prices, or (2) an increase of more than 25 per cent in the quantity of any one major contract item, including earth or common roadway excavation but not including excavation of any other class nor items of foundation piling. Alterations involving an increase of more than 25 per cent in the quantity of any one minor contract item will not require a supplemental agreement. Before work shall be started on any alteration requiring such supplemental agreement, the agreement setting forth an equitable adjustment of compensation satisfactory to the Contractor shall be executed by the Engineer and the Contractor. The Contractor shall perform the work as increased or decreased.

4.4 Extra Work. The Contractor shall perform extra work, for which there is no quantity and price included in the contract, whenever the same is ordered in writing by the Engineer, and such extra work shall be done in accordance with the specifications therefor, or as directed. Such work will be paid for at a unit price or lump sum to be agreed upon previously in writing by the Contractor and the Engineer; or where such a price or sum cannot be agreed upon by both parties, or where such method of payment is impracticable, the Engineer shall authorize the Contractor in writing to do such work on a Force Account Basis, and no such extra work will be paid for unless it shall have been previously so authorized.

4.5 Maintenance of Detours. Whenever possible the portion of the highway under immediate construction will be closed by the proper authorities, and traffic detoured over existing adjacent highways. However, the Contractor shall conduct the work so as to interfere as little as possible with necessary traffic. He shall provide and maintain in passable condition such temporary highways and bridges as may, in the judgment of the Engineer, be necessary to accommodate the essential traffic, and particularly mail transportation, that cannot in the opinion of the Engineer be detoured over

other existing highways; provided, however, that the Contractor will not be required to provide right of way for temporary highways or bridges; and provided further, that all work ordered in connection with the construction and maintenance of temporary highways and bridges will be classed as "Extra Work" and paid for as elsewhere herein stipulated, unless otherwise provided in these specifications. He shall provide and maintain temporary approaches to and crossings of intersecting highways. All footways, gutters, sewer inlets and portions of highways adjoining the improvement shall be obstructed no more than is absolutely necessary.

Should the Engineer, on account of unfavorable weather or other conditions not the fault of the Contractor, authorize a suspension of construction operations for a considerable period of time, the Contractor shall make passable and shall open to traffic such portion of the highway under improvement and such temporary roadways or portions thereof as may be agreed upon between the Contractor and the Engineer for the temporary accommodation of necessary traffic during the anticipated period of suspension, unless otherwise provided in these specifications. Thereafter and until the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon shall be by and at the expense of the State; provided, however, that when work is resumed the Contractor shall at his own cost and expense replace or renew any work or materials lost or damaged because of such temporary use of the highway under improvement; shall remove any work or materials used in the temporary maintenance thereof by the State; and shall complete the improvement in every respect as though its prosecution had been continuous and without interference. All work ordered in connection with making passable the temporary roadways agreed upon, (but not the highway under improvement) will be classed as "Extra Work" and paid for as elsewhere herein stipulated, unless otherwise provided in these specifications.

4.6 Removal and Disposal of Structures and Obstructions. All obstructions, structures not designated for use, obstructing fences, etc., shall be removed and disposed of by the Contractor, or otherwise, as may be directed by the Engineer.

It is intended that all buildings within the right of way shall be moved by the owner prior to the beginning of grading operations by the Contractor. In case the buildings are not removed by the owner in time to prevent interference with grading operations, they shall be removed by the Contractor and payment therefor shall be made on a force acount basis as herein provided for in Article 9.4.

4.7 Rights in and Use of Materials Found on the Work. The Contractor may use in the construction of the surface or structures any suitable stone, gravel, sand, timber or other materials found on the work that meet all the requirements of these specifications relating to character and quality for the particular use intended. Materials so used and paid for under some other item, will not be paid for as "Excavation," "Clearing," etc., except that; when materials contemplated for use in embankments are otherwise used by the Contractor with the result that borrow, not originally contemplated, is necessitated, the Contractor will be paid on a basis that is most economical for the State. The Contractor shall not excavate or remove any material from within the highway location, which is not within the excavation as indicated by the slope and grade lines, without written authorization by the Engineer.

4.8 Final Cleaning Up. Upon completion of the work and before acceptance and final payment shall be made, the Contractor shall clean and remove from the highway and adjacent property, all surplus and discarded materials, rubbish, and temporary structures, restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of the work, and shall leave the highway in a neat and presentable condition throughout the entire length of roadway under contract.

If any gravel pit is so located as to be visible from the highway, special care shall be taken by the Contractor in making the final cleanup. The gravel shall be taken out so as to leave the side banks with as uniform lines as possible, and if required by the Engineer in order to produce a neat appearance, the side banks shall be neatly trimmed. The floor of the pit shall be left smooth and all piles of rock wasted because they were too large to be handled by the crusher shall be spread neatly over the floor of the pit or otherwise disposed of so as not to be visible from the highway. The strippings from all pits visible from the highway shall be neatly spread over the adjacent territory or shall be dragged into the pit and there spread as directed by the Engineer unless the Engineer orders that the strippings be left in ridges in order to act as wind breaks and snow barriers. No extra compensation shall be allowed for the final cleaning up of the gravel pits, but the cost thereof shall be included in the unit price bid for the material in the finished course or courses.

SECTION 5.

CONTROL OF THE WORK.

5.1 Authority of Engineer. All work shall be done under the direct supervision of the Engineer and his authorized assistants. To prevent misunderstanding and litigation, the Engineer shall decide any and all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of said work, and shall decide all questions which may arise as to the interpretation of any or all plans relating to the work and of the specifications, and all questions as to the acceptable fulfillment of the contract on the part of the Contractor, and such decision shall be final and conclusive, except that the Contractor shall not be estopped from resorting to legal process in the event that the decision of the Engineer with respect to the matters above enumerated is not acceptable.

5.2 Plans and Working Drawings. Plans and working drawings will be furnished, and in all cases they will form a part of the Contract. Road plans will show in detail structures up to and including 20-foot spans, alignments, grades, cross-sections and typical cross-section of the improvement; bridge plans for structures of over 20-foot span will be furnished separately, and will show the general layout and features and all necessary details. Such supplementary bridge and falsework plans, shop details, etc., as may be necessary shall be furnished by the Contractor, but shall not be used until after approval by the Engineer. No extra compensation will be allowed for such drawings. Alterations authorized by the Engineer will be endorsed on approved plans or shown on supplementary sheets. Additional details relative to working drawings will be furnished as required. It shall be expressly understood that the approval by the Engineer of the Contractor's working drawings relates to the requirements for strength and detail and such approval will not relieve the Contractor from the responsibility for errors in dimensions.

5.3 Conformity With Plans and Allowable Deviations. The approved plans, profiles, and cross-sections, will show the location, details and dimensions of the work contemplated, which shall be performed in strict accordance therewith, and in accordance with the specifications. Any deviation from the plans that may be required by the exigencies of construction, in all cases will be determined by the Engineer and authorized in writing.

5.4 Coordination of Specifications, Plans and Special Provisions. All requirements of the specifications, plans and special provisions shall be binding upon the Contractor. On all plans and drawings the figured dimensions shall govern in case of discrepancy between figured dimensions and scaled dimensions. Modifications of these standard specifications may be indicated by notations on the plans or in the special provisions for a particular contract; and in every case of such modification, or of discrepancies between the standard specifications and the plans and special provisions, the plans shall govern over the standard specifications and the special provisions shall govern over both the standard specifications and the plans. The Contractor shall take no advantage of any error or omission in the plans or of any discrepancy between the standard specifications, plans, and special provisions, and the Engineer shall make such corrections and interpretations, in full accordance with the principles described above in this article, as may be deemed necessary for the fulfillment of the specifications, plans and special provisions as construed by him, and his decision shall be final.

5.5 Cooperation by Contractor. The Contractor will be supplied by the Engineer with two sets of approved plans, specifications and special provisions, including authorized alterations thereof; one set of which the Contractor shall keep available on the work at all times during the prosecution thereof. He shall give the work his constant attention, and shall co-operate with the Commission in every way possible. He shall have at all times, a competent and reliable English-speaking representative on the work, authorized to receive orders and to act for him. Where two or more contractors are engaged upon work on the same project or section of the project, or upon work in the same vicinity, each shall be responsible to the other for any damage, injury, loss or expense which may be suffered on account of interference of operations, neglect or failure to finish work at the proper time, or for any other cause.

5.6 Construction Stakes. The Engineer will furnish and set all survey and grade stakes necessary for the guidance of the Contractor in the prosecution of the work. The Contractor shall furnish, free of charge, all templets and materials other than stakes necessary for marking and maintaining points and lines given; and, without expense to the Commission, shall furnish the Inspector such assistance or assistants as may be required in giving points and lines necessary to the prosecution of the work. The Contractor shall be held responsible for the preservation of all stakes and marks and if in the

opinion of the Engineer any of the survey stakes or marks have been carelessly or wilfully destroyed or disturbed by the Contractor, the cost to the Commission of replacing them will be charged against him and deducted from the payment for the work. Finished surfaces, in all cases, shall conform to the lines and grades given and as shown on the approved plans.

The crown rise of the finished surface of the roadway, from the curb or side-line to the center, shall be as shown on the typical cross-section of the plans, except at intersecting highways, or wherever to insure correct drainage or for other reasons changes may be directed. On curves or at other places where deemed necessary, the Contractor may be required to bank the roadway so that the finished surface shall slope in one direction from one side to the other.

5.7 Authority and Duties of Inspectors. Inspectors, employed by the Commission, will be authorized to inspect all work done, and materials furnished. Such inspection may extend to all or any part of the work and to the preparation or manufacture of the materials to be used; but such inspection shall not relieve the Contractor from any obligation to perform all of the work strictly in accordance with the requirements of the specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector shall have the authority to reject materials or suspend prosecution of the particular work affected until the questions at issue can be referred to and decided by the Engineer. The Inspector shall not be authorized to revoke, alter, enlarge, or relax any requirements of these specifications, nor to finally approve or accept any portion of work, nor to issue instructions contrary to the plans and specifications. Any advice inconsistent with the requirements of the plans, specifications or contract, which the Inspector may give the Contractor, shall in no wise be construed as binding the Engineer or the Commission in any way, nor releasing the Contractor from the fulfillment of the terms of the contract. The Inspector shall not be authorized to act as Foreman for the Contractor, nor to interfere with the management of the work.

5.8 Inspection. The Contractor shall furnish the Engineer with every reasonable facility for ascertaining whether or not the work as performed is in accordance with the requirements and intent of the specifications and contract. Any work done or materials used without suitable supervision or inspection by a Commission representative may be ordered removed and replaced at the Contractor's expense.

5.9 Removal of Defective and Unauthorized Work. All materials not conforming to the requirements of these specifications shall be considered as defective and all such materials, whether in place, or not, will be rejected and shall be removed immediately from the highway unless otherwise permitted. All work which has been rejected or condemned shall be remedied, or if necessary, removed and replaced in an acceptable manner by the Contractor at his own expense. Upon failure on the part of the Contractor to comply promptly with any order of the Engineer made under the provisions of this Article, the Engineer shall, after giving written notice to the Contractor, cause defective work to be remedied, or removed and replaced, cause unauthorized work to be removed, and deduct the cost thereof from any compensation due or to become due the Contractor.

5.10 Final Inspection. Final inspection of the work will be made by the Engineer or his authorized assistant within fifteen days after the final cleanup following completion of the project.

SECTION 6.

CONTROL OF MATERIAL.

6.1 Source of Supply and Quality. The Engineer will require that sources of supply of each of the materials shall be approved by him before delivery is started. Only materials conforming to the requirements of these specifications and approved by the Engineer shall be used in the work. All materials proposed to be used may be inspected at any time during the progress of their preparation and use. If, after trial, it is found that partially developed quarries, ledges, banks, pits or other sources of supply, which have been approved upon samples or otherwise, do not furnish a uniform or satisfactory product, the Contractor shall furnish approved material from other sources. Any material which, after approval, has become mixed with or coated by any foreign substance during its delivery and handling shall not be used in the work. Unless specifically stated in the Special Provisions, the Commission will make no attempt to designate, prior to the receipt of proposals, acceptable sources of supply for materials, and the unit prices named in the proposal shall be understood to be based upon the use of satisfactory materials. If a certain source or sources of supply shall have been set forth in the Special Provisions, the unit price named in the proposal shall be understood to be based upon the use of material obtained from the designated source. Should it develop later that material

obtained from such designated source or sources is not acceptable, the Contractor will be reimbursed only for the actual additional expense of hauling or transportation from an acceptable source, and then only in the event that the Contractor is actually caused additional hauling or transportation expense as a result of the rejection of the designated source.

6.2 Plant Inspection. If the volume, progress of the work, and other considerations warrant, the Engineer may undertake the inspection of materials at the sources of supply. Plant inspection, however, will not be undertaken until the Engineer is assured of the cooperation and assistance of both the Contractor and the material producer. The representative of the Commission shall have free entry at all times to such parts of the plant as concern the manufacture or production of the materials ordered, and the material producer shall furnish free of charge all reasonable facilities to assist in determining whether the material furnished meets with the requirements of the specifications. The Commission assumes no obligation to make the inspection of materials at the source of supply, and the responsibility of securing satisfactory materials rests entirely with the Contractor.

The Commission reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered, and to reject all materials which when retested do not meet the requirements of the specifications.

The Contractor shall give sufficient notification of the placing of orders for materials to permit testing.

6.3 Samples and Tests. Samples as prescribed or required shall be submitted by the Inspector, Contractor or producer for testing. Tests shall be made in accordance with the Tentative Standard Specifications for Methods of Sampling and Testing as adopted by the American Association of State Highway Officials in so far as covered therein. Test methods which are not covered in this publication shall conform to the standard specifications of the American Society for Testing Materials or by such other recognized standard methods as may be specified or described in these specifications or designated by the Engineer.

The Contractor shall afford such facilities as the Engineer may require for collecting and forwarding samples, and shall not make use of or incorporate in the work any material represented by the samples until the tests have been made and the materials found to be acceptable in accordance with the requirements of the specifications. The Contractor shall furnish without charge all samples required.

When required by the Engineer or requested by the Contractor, representative preliminary samples of the character and quantity prescribed shall be submitted for examination and shall be tested in accordance with the methods referred to herein. The acceptance of a preliminary sample shall not be construed as acceptance of materials from the same source delivered later, unless such materials are found to be of equal or of better quality than the preliminary sample. Only the materials actually delivered for the work will be considered and their acceptance or rejection will be based solely on the results of the tests prescribed in these specifications.

6.4 Storage. Materials shall be stored so as to insure the preservation of their quality and fitness for the work. Stored materials shall be located so as to facilitate prompt inspection.

That portion of the right of way not required for public travel may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required shall be provided by the Contractor at his expense. Where more than one contractor is engaged upon work on the same project or section of the project, or upon work in the same vicinity, the use of the highway right of way for storage purposes, for placing the Contractor's plant and equipment, or for camp purposes shall be contingent upon such use not interfering with the construction operations of other contractors, and if ordered by the Engineer, the Contractor shall promptly move his stored materials, plant, equipment, and camp to a location where it will not interfere with any construction operation.

6.5 Defective Materials. Materials not conforming to requirements shall be rejected and removed from the work, and shall be replaced by acceptable materials and in an acceptable manner by the Contractor and at his expense. The Engineer may remove defective materials and charge the expense thereof against the Contractor.

SECTION 7.
LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC.

7.1 Laws to Be Observed. The Contractor shall at all times observe and comply with all Federal and State Laws, and local by-laws, ordinances and regulations in any manner affecting the conduct

of the work, and shall indemnify and save harmless the State and all of its officers, agents, and servants against any claim or liability arising from or based on the violation of any such law, by-law, ordinance, regulations, order or decree, whether by himself or his employees.

7.2 Permits and Licenses. The Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, except that nothing herein contained shall be construed as requiring the Contractor to secure right-of-way for the road proposed for improvement.

7.3 Patented Devices, Materials and Processes. The Commission assumes the responsibility of defending any and all suits brought for the infringement of any patent claimed to be infringed by the design, or general type of structure provided for in plans furnished the Contractor by the Commission, and to hold the Contractor harmless on account of such suits or claims for royalty.

The Contractor assumes the responsibility of defending any and all suits brought for the infringement of any patent claimed to be infringed in any method, process, material or machinery which he may use in the execution of the work.

The Contractor must assume all responsibility for plans submitted by him for the use of the Engineer and shall hold the Commission harmless from any suits, royalty or damages on account of the infringement of any patents by said plans.

7.4 Restoration of Surfaces Opened by Permit. Any individual, firm or corporation wishing to make an opening in the highway must secure a permit from and will be required to deposit security with the Commission, in a suitable amount, to cover the cost of making necessary repairs, and the Contractor shall not allow any person or persons to make an opening unless duly authorized by the Engineer. Until the acceptance of the work performed under these specifications and contract, the Contractor shall make all necessary repairs, within the time indicated in writing by the Engineer, and in an acceptable manner, at any point or points in the roadway where any opening has been made by authority of the Engineer. Such repair work will be paid for as "Extra Work," as indicated in these specifications and said work shall be subject to the same conditions as the work regularly performed under this contract.

7.5 Federal Participation. The attention of the Contractor is directed to the provisions of the Federal Highway Act, approved November 9, 1921 (42 Statute 212), and amendments thereto. When the United States Government is to pay a portion of the cost of construction, the above Act of Congress provides that the construction work in each State shall be done in accordance with its laws and under the direct supervision of the Commission, subject to the inspection and approval of the Secretary of Agriculture and in accordance with the rules and regulations made pursuant thereto. The construction work, therefore, will be subject to such inspection by the United States Secretary of Agriculture, or his agents, as may be necessary to meet the above requirements but such inspection will in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party hereunder, nor will it subject the Contractor to compliance with the Federal Laws relative to labor, etc., on Government contracts.

7.6 Sanitary Provisions. The Contractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State Board of Health or of other bodies or tribunals having competent jurisdiction. He shall commit no public nuisance.

7.7 Public Convenience and Safety. The Contractor shall at all times so conduct his work as to insure in the greatest possible degree the uninterrupted convenience and safety of the traffic and the public in the vicinity of the work. No road shall be closed to the public except by the express permission of the Engineer. For additional instructions refer to the article above on "Maintenance of Detours."

7.8 Barricades, Danger, Warning and Detour Signs. The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient red lights, warning and danger signals and signs, provide a sufficient number of watchmen and take all necessary precautions for the protection of the work and safety of the public. The Commission will provide and the Contractor shall erect and maintain acceptable and adequate detour signs at all closures and along the detour routes. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. Barricades used by the Contractor shall conform to the standard design attached to the plans.

7.9 Use of Explosives. In the use and storage of explosives, the Contractor shall use every precaution to prevent injury to persons and damage to property. Secure storage places shall be provided and all such places shall be clearly marked with warning signs. Only persons experienced in the handling of explosives shall be allowed to use them on the work, and no shot shall be fired until warning has been sounded and all persons within a radius of danger removed. Whenever directed by the Engineer, the number or intensity of charges shall be reduced.

In the handling and storage of explosives, the Contractor must comply with all Federal, State and local laws, and the State will in no way be responsible for any non-compliance therewith or for damages to property or injury to persons resulting from accidental or premature explosions or from any damage attributable to the use of such explosives.

7.10 Preservation and Restoration of Property, Trees, Monuments, Etc. The Contractor shall be responsible for the proper preservation of all public and private property, monuments, etc., along and adjacent to the roadway. He shall use suitable precautions to prevent damage to pipes, conduits and other underground structures, and shall protect from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and he shall not remove them until directed. The Contractor shall not wilfully or maliciously injure or destroy shade trees or shrubs and he shall not remove or cut them without proper authority.

The Contractor shall be solely responsible for any trespass upon adjacent property or injury thereto, resulting from or in connection with his operations. He shall be liable for any claims that may be made on account of the falling of trees or the deposit of debris of any kind upon private property.

The Contractor shall restore, replace, or otherwise make good the loss or damage of, the above described property, or upon notice the Engineer may cause such restoration, replacement or indemnification, and charge same against moneys due or to become due the Contractor.

7.11 Responsibility for Damage Claims. The Contractor shall save and keep harmless the State of Montana and any county, city or town thereof against and from all losses to it from any cause whatever growing out of the prosecution of the work. The Engineer may retain from moneys due, or to become due, the Contractor, a sufficient amount to insure the enforcement of this provision.

The Contractor shall carry public liability insurance to indemnify the public for injuries or damages sustained by reason of the carrying on the work. This insurance shall be in the amount of at least $10,000.00 for one person and a total of $20,000.00 for one accident. The Contractor shall submit adequate evidence to the Commission that he has taken out this insurance.

7.12 Opening of Section of Highway to Traffic. Whenever, in the opinion of the Engineer, any roadway, or portion thereof, is in acceptable condition for travel, and is required for the convenience of the public, it may be opened to traffic as directed, and such opening shall not be held to be in any way an acceptance of the roadway, or any part of it, or as a waiver of any of the provisions of these specifications and contract. Necessary repairs or renewals made on any such section of the roadways so opened, due to defective materials or work, or to cause other than ordinary wear and tear, pending completion and acceptance of the roadway, shall come under the provisions of the article next hereunder.

If such roadway or portion thereof shall have been finished previously in a manner acceptable to the Engineer, the Contractor shall be relieved of the maintenance thereof; but if it has not been previously so finished, it shall be maintained in a serviceable condition by the Contractor at his own expense, until such time as it is finished in an acceptable manner.

The acceptance of any portion or portions of the roadway prior to the acceptance of the work as a whole shall be understood to be an acceptance only in so far as it relieves the Contractor of the maintenance of such portion or portions. It will not entitle him to payment of any part of the retained percentage, and it will not relieve him from responsibility for defective workmanship or materials.

In the case of a contract for the placing of a surface course or courses upon a grade previously constructed under a separate contract, the Contractor shall not be required to maintain the subgrade ahead of his actual trenching or other operations covering the preparation of the subgrade.

7.13 Contractor's Responsibility for Work. (a). Until its acceptance by the Engineer, the improvement shall be under the care and charge of the Contractor, and he shall be responsible for and shall repair and make good any injury or damage to the improvement or to any part thereof from any cause whatsoever; except that the Contractor will not be held responsible for injury or damage to the improvement or any part thereof when, in the opinion of the Engineer, such damage is not the result of careless, negligent or dilatory work on the part of the Contractor, but is the result of unforeseen natural causes beyond the control of the Contractor, such as violent storms, cloudbursts and

floods. The judgment of the Engineer in this matter shall be final, and binding upon both parties to the contract. When a Contractor has, through dilatory methods and other causes within his control, exceeded his contract time unjustifiably, and has therefore been denied an extension of his contract time, the saving clause in the next preceding sentence shall not apply, but he shall be responsible for all damage of every nature.

(b) The above saving clause shall not apply to bridge contracts. The Contractor in submitting proposals for such work must be governed by his own judgment as to probable weather and stream conditions and the actual resulting conditions will never be considered as unforeseen, but any loss or damage of any nature prior to acceptance of the improvement by the Engineer shall be the responsibility of the Contractor.

7.14 **No Waiver of Legal Right.** The commission or the Engineer shall not be precluded or estopped by any measurements, estimate or certificate, made or given by them, or by any agent or employee of the Commission, under any provision, or provisions, of the contract, at any time, either before or after the completion and acceptance of the work and payment therefor pursuant to any measurement, estimate or certificate, from showing the true and correct amount and character of the work performed and materials furnished by the Contractor, or from showing, at any time, that any such measurement, estimate, or certificate is untrue or incorrectly made in any particular, or that the work or materials, or any part thereof do not conform in fact to specifications and contract, and the Commission shall have the right to reject the whole or any part of the aforesaid work or materials, should the said measurement, estimates, certificate or payment be found, or be known to be, inconsistent with the terms of the contract, or otherwise improperly given, and the Commission shall not be precluded and estopped, notwithstanding any such measurement, estimate, certificate and payment in accordance therewith, from demanding and recovering from the Contractor and his Surety such damages as it may sustain by reason of his failure to comply with the terms of the specifications and contract. Neither acceptance by the Commission, the Engineer or any agent or employee of the Commission, nor any certificate by the Commission for payment of money, nor any payment for nor acceptance of the whole or any part of the work by the Commission, or Engineer, nor any extension of time nor any possession taken by the Commission or its employees, shall operate as a waiver of any portion of the contract or of any power herein reserved by the Commission, or any right to damages herein provided, nor shall any waiver of any breach of the contract be held to be a waiver of any other or subsequent breach.

7.15 **Familiarity With Laws, Etc.** The Contractor is assumed to have made himself familiar with all Federal and State Laws and local by-laws, ordinances and regulations which in any manner affect the work or those engaged or employed in the work and no plea of misunderstanding will be considered on account of his ignorance thereof. If the Bidder or Contractor shall discover any provision in the plans, specifications or contract which is contrary to or inconsistent with any such law, by-law, ordinance or regulations, he shall forthwith report it to the Commission in writing.

The Contractor's attention is directed particularly to the provisions and requirements of the Workmen's Compensation Act, being Chapter 96 of the Session Laws of the Fourteenth Legislative Assembly of the State of Montana and amendments thereof; also to the statutes regulating the hours of employment on public work.

7.16 **Responsibility of Contractor for Damage to Railways and Like Properties.** At points where the Contractor's operations are adjacent to properties of railway, telegraph, telephone and power companies, or are adjacent to other property, damage to which might result in very considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall be solely and directly responsible to the owners and operators of such properties for any damage, injury, expense, loss, inconvenience or delay, or for any suits, actions, or claims of any character brought on account of any injuries or damages which may result from the carrying out of the work to be done under this contract and, if required by the Commission, he shall give bond in an amount not to exceed fifty thousand dollars, to each corporation, company, partnership, or individual owning or operating any of the properties affected, in guarantee of this responsibility.

If the construction work is in such close proximity to railway tracks that the railway company deems it necessary to provide flagmen or other means of protection for their traffic, all such expense shall be repaid to the railway company by the Contractor or deducted from any compensation due or to become due the Contractor. Likewise the cost of cabling telephone or telegraph wires or other expense incurred in protecting such wires shall be repaid by the Contractor.

7.17 Right of Way. All right of way for the roadway shall be provided by the Commission without cost to the Contractor. All right of way may not have been obtained at the time when the bids are opened, and the contract let, and in that case the award will be made conditional upon the Contractor not beginning work on sections where the right of way has not been secured until that right of way has been obtained and the Contractor is authorized to enter upon those sections. The submission of a bid will be construed as an acceptance of this condition by the bidder, and no claim for damage or loss of anticipated profits on account of unavoidable delay in securing right of way will be considered by the Commission. If the contract is materially delayed because of right of way difficulties, due consideration will be given by the Commission in extending the contract time to make proper allowance therefor.

7.18 Gasoline Tax Refunds. It is understood and agreed that the unit prices bid by the Contractor include the state tax on all gasoline used in the performance of the work, including that used in the operation of stationary gas engines and for all other uses, as well as that used in motor vehicles; and it is further agreed that if any refund of said state tax is received by the Contractor or by his subcontractors or employees, the amount thereof shall be credited to the State Highway Commission on accounts due to the Contractor under this contract, or shall be paid to the State Highway Commission by the Contractor, in cash or by certified check.

SECTION 8.

PROSECUTION AND PROGRESS.

8.1 Assigning or Subletting of Contract.

(a) *Assignment of Contract.*

The Contractor shall not assign, transfer, convey or otherwise dispose of his contract or his right, title or interest therein to any other person, firm or corporation without the written consent of the Commission.

The Commission will not recognize nor accept an advance "blanket" assignment by the Contractor to any bank or other third party under the provisions of which all payments due or to become due the Contractor are proposed to be paid direct to such third party rather than to the Contractor. The Commission will recognize a request by the Contractor to deposit payments to his credit in any stipulated bank.

(b) *Subletting.*

The Contractor shall not sublet any portion of the contract without the previous written consent of the Commission. Consent on the part of the Commission will be given only when in its opinion the best interests of the State will be served by so doing. The subletting of any or all of the work will in no way relieve the Contractor of any responsibility under his contract and the Commission may for cause order any or all sub-contracts canceled and the sub-contractors removed from the work. Any loss or damage that may be suffered on account of such action shall be borne by the Contractor. Subcontractors will be recognized only in the capacity of foremen or responsible employees of the Contractor; and except as such they shall have no relations with the Commission.

Each and every sub-contract shall be in writing and shall provide that the work be performed in accordance with all the provisions of the agreement or contract obligating the general contractor. Certified copies of all sub-contracts shall be furnished to the Commission for approval before execution by the parties to such sub-contract and a copy of such approved sub-contract shall be filed with the Commission after execution by the parties thereto.

Under no circumstances may more than one sub-contractor be interested in the same contract item over the same section of highway or at the same location. (Note: the purpose of this provision is to prevent the practice of subletting certain work which is again sublet to a second sub-contractor, who in turn may sublet to a third sub-contractor and so on. Such practice will not be permitted.)

8.2 Prosecution of Work. The Contractor shall begin the work to be performed under this contract within ten (10) days after the execution of the contract therefor. The work shall be conducted in such a manner and with sufficient materials, equipment and labor as will insure its completion within the time set forth in the contract. Should the prosecution of work for any reason be discontinued by the Contractor, with the consent of the Engineer, he shall notify the Engineer at least forty-eight (48) hours before again resuming operations.

The Contractor shall notify the Engineer, in writing, five (5) days in advance of the date he expects to start work and when he expects to begin important features of construction.

The place of starting work will be determined and designated by the Engineer, and work will be progressively prosecuted at points as ordered by him.

8.3 Limitations of Operation. The Contractor shall not open up additional work to the prejudice or delay of work already started, nor shall he inconvenience traffic more than is necessary as determined by the Engineer. At no time during the prosecution of the work shall more than two (2) miles of continuous roadway be under construction or obstructed to traffic without permission of the Engineer. The final shaping of roadway ditches and borrow pits, the final finishing of earth graded roads, and the fine grading of subgrade and shoulders shall follow the rough grading as closely as possible. The laying and finishing of surface courses shall follow the completion of the fine grading of the subgrade and shoulders as closely as permitted by the Engineer.

8.4 Character of Workmen and Equipment. The Contractor shall employ such superintendents, foremen and workmen as are careful and competent, and the Engineer may demand the dismissal of any person or persons employed by the Contractor in, about or upon the work, who shall misconduct himself or be incompetent or negligent in the due and proper performance of his or their duties, or who neglects or refuses to comply with the directions given; and such person or persons shall not be employed again thereon without the written consent of the Engineer. The Contractor shall furnish such adequate and proper equipment as is necessary for the proper prosecution of the work as specified.

8.5 Temporary Suspension of Work. The Engineer shall have the authority to suspend the work, wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather or to such other conditions as are considered unfavorable for the suitable prosecution or protection of the work, or for such time as is necessary on account of failure on the part of the Contractor to carry out orders given or to perform any or all provisions of the contract. If it should become necessary to suspend work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and he shall take every precaution to prevent damage or deterioration of the work performed, provide suitable drainage of the roadway by opening ditches, shoulder drains, etc. The Contractor shall not suspend the work without authority.

8.6 Determination and Extension of Contract Time for Completion. The date for completion will be determined by the Engineer before proposals are called for, and will be specified in the Proposal Form and Contract.

The Contractor shall complete the work within the time limit specified, and elapsed time will be computed in calendar days. Requests for extension of contract time will be granted by the Commission only when it is clearly shown that, by a reasonable and possible increase in force and equipment, the Contractor cannot complete the work within the time agreed upon. In planning his organization, the Contractor must make allowance for lost time due to unfavorable weather and other conditions and must provide such force of men and equipment as may reasonably be expected to complete the work within the time specified.

Note: The Commission will consider a request by the Contractor for extension of time of completion of the contract on account of strikes, inability to secure sufficient laborers or because of other unfavorable conditions clearly beyond the control of the Contractor.

8.7 Failure to Complete the Work on Time. It is understood and agreed that time is the essence of the contract and that the work must be completed within the time specified in the proposal and contract. Should the Contractor fail to complete the work within the time specified in the proposal and contract, or within any authorized extension thereof, and if the Commission does not terminate the right of the Contractor to proceed, the Contractor shall continue and complete the work; in which event, the actual damages for the delay will be impossible to determine and in lieu thereof the Contractor shall pay to the Commission as fixed, agreed and liquidated damages for each calendar day that the work shall remain uncompleted beyond the completion date the sum set forth in the following schedule. The Contractor shall be liable for the payment of the amount thereof, which amount shall be deducted from the final payment due the Contractor under the contract.

SCHEDULE OF LIQUIDATED DAMAGES.

Contract Price	*Liquidated Damages*
Less than $50,000	$25.00 per day
$ 50,000 and less than $100,000	$30.00 " "
$100,000 and less than $200,000	$35.00 " "
$200,000 and less than $300,000	$40.00 " "
$300,000 and over	$50.00 " "

8.8 Annulment of Contract. If the Contractor fails to comply with any of the requirements of the plans or specifications, or shall discontinue the prosecution of the work, or if the Contractor shall become insolvent or bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or from any other cause whatsoever shall not carry on the work in an acceptable manner, the Engineer shall give notice in writing to the Contractor and his Surety of such delay, neglect or default, specifying the same, and if the Contractor within a period of three (3) days after such notice shall not proceed in accordance therewith, then the Commission shall, upon written certificate from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said Contractor, to appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement with any other person or persons for the completion of said contract according to the terms and provision thereof, or use such other methods as it may deem expedient for the completion of said contract in the specified manner. All costs and charges incurred by the Commission, together with the costs of completing the work under contract, shall be deducted from any moneys due or which may become due said Contractor. In case the expense so incurred by the Commission shall be less than the sum which would have been payable under the contract, if it had been completed by said Contractor, then the said Contractor shall be entitled to receive the difference; and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and the Surety shall be liable and shall pay to the State the amount of said excess.

8.9 Termination of Contractor's Responsibility. The contract shall be considered to have been completely fulfilled when all work has been completed and accepted by the Engineer and the final estimate has been accepted by the Contractor and paid. The Contractor shall then be released from further obligation under the contract except as set forth in his Contract Bond.

SECTION 9.
MEASUREMENT AND PAYMENT.

9.1 Measurement of Quantities. The determination of quantities completed under the contract will be made by the Engineer, based upon actual measurement of the work according to the United States standard measures. In computing volumes, the method of average end areas will be used for excavation and embankment. All linear surface measurements will be made along the actual surface of the improvement and not horizontally. The area of surfacing to be paid for will be only the actual area covered by the entire surfacing or paving material within the lines designated or given, except that no deduction will be made for fixtures in the roadway or street of four square feet or less. Concrete and other similar structures, excavation for structures and other similar items will be measured, and volumes will be computed according to the neat lines shown on the plans or ordered by the Engineer. Other quantities will be computed in units indicated in the proposal form according to well established engineering principles, and no local rules or customs at variance therewith will be considered.

9.2 Scope of Payments. The Contractor shall receive and accept the compensation, as herein provided, in full payment for all work contemplated and embraced under the contract, also for all loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof. The payment of any current or final estimate, or of any retained percentage shall in no way or in no degree prejudice or affect the obligation of the Contractor to submit for final acceptance a completed improvement in accordance with the requirements of the plans, specifications and supplemental agreements.

The Contractor shall promptly make payment for labor and material, at such times as claims therefor become due and payable, to all persons supplying said Contractor therewith for the prosecution of the work contemplated herein, and he shall not permit any lien or claim to be filed or prosecuted against the State of Montana, or any officer, agent or employee thereof for or on account of any labor or material furnished.

9.3 Payment and Compensation for Altered Quantities. When alterations in plans or quantities of work not requiring supplemental agreements as hereinbefore provided, are ordered and performed, the Contractor shall accept payment in full at the contract unit prices for the actual quantities of work done and no allowance will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations, or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefor, or from any other cause.

Concrete quantities shown in the bidding schedule may have been increased 10%, roadway and structure excavation quantities 15%, and base course surfacing quantities 20% in order to cover possible over-runs, but only accepted quantities actually entering into the final construction will be paid for.

9.4 Extra and Force Account Work. Extra work as hereinbefore described under the sub-heading, "Scope of Work," shall be paid for either at agreed unit prices under the provisions of a "Supplemental Agreement," or on a "Force Account" basis, as shall have been agreed by the Engineer and Contractor before starting said work.

Supplemental Agreement. When it has been agreed to perform certain extra work not contemplated in the original Proposal and Contract on the basis of agreed prices, a "Supplemental Agreement" will be prepared fully describing said extra work, including the approximate quantity as nearly as may be arrived at in advance of the performance of the work, and the agreed unit prices. This "Supplemental Agreement" shall be executed by both parties to the original contract, shall thereupon be considered a part of the contract, and payment for the work included therein shall be for the actual quantity performed at the agreed unit prices set forth therein. Extra work provided for by a "Supplemental Agreement" shall not be started until after the execution of the said agreement.

Force Account Work. Where extra work on a "Force Account" basis has been ordered by the Engineer in writing as provided above under the sub-heading, "Scope of Work," it shall be paid for in the following manner:

(a). For all labor, teams and foremen in direct charge of the specific operation, the Contractor shall receive actual direct payroll cost plus fifteen (15) per cent.

(b). For all materials used, the Contractor shall receive the actual delivered cost of such materials as shown by original receipted bills, plus ten (10) per cent.

(c). For any machine-power tools or equipment, including fuel and lubricants, which it may be deemed necessary or desirable to use, the Engineer shall allow the Contractor a reasonable rental price, to be agreed upon in writing before such work is begun, for each and every hour or day that said tools or equipment are in use on such work and to which sum no percentage shall be added.

(d). For Workmen's Compensation Insurance, Public Liability and Property Damage Insurance, and Premium on the Performance Bond, the Contractor shall receive the actual cost thereof chargeable to the force account work, to which no percentage shall be added. The Contractor shall furnish satisfactory evidence of the rate or rates paid for insurance and bond.

(e). The compensation as herein provided shall be received by the Contractor as payment in full for extra work done on a "force account" basis, and shall include superintendence, use of tools and equipment for which no rental is allowed, and profit. The Contractor's record of extra work done on a "force account" basis shall be checked by the Inspector at the end of each day, and a copy of these records, signed by both the Inspector and the Contractor's representative, forwarded to the Engineer. All claims for extra work done on a "force account" basis shall be submitted o estimate forms furnished by the Commission, accompanied by the original Extra Work Order and receipted material and freight bills. Such claims shall be submitted to the Engineer not later than the tenth (10th) day of the month following that in which the work was actually performed.

Note: Payment for Extra Work, including Force Account Work, will not be included in the regular monthly progress estimates; but such work will be included in the final estimate and will be paid for at that time.

9.5 Omitted Items. It is hereby provided that the Engineer may order omitted from the contract items included in the original contract which may later be found unnecessary to the improvement, without thereby in any manner nullifying the contract or any of the other provisions thereof; provided, however, that the Contractor has paid for material or incurred other expense in relation to any such item, before the elimination of same is ordered, he shall be reimbursed for his actual costs as evidenced by paid invoices, paid time checks and other similar evidence which may be demanded by the Engineer to fully support the cost statement of the Contractor. In no case of this sort shall any allowance be made for anticipated profits.

9.6 Unauthorized Work. Work done without lines or grades being given, work done beyond the lines or grades shown on the plans or as given, except as herein provided, or any extra work done without written authority will be considered as unauthorized and at the expense of the Contractor and will not be measured or paid for. Work so done may be ordered removed or replaced at the

Contractor's expense. In measuring quantities no allowance will be made for excavation or embankment in excess of that required by the sections shown on the plans unless such increase in quantity has been authorized in writing by the Engineer.

9.7 Partial Payments. The Engineer shall make estimates in writing each working month of the materials in place complete and the amount of work performed, exclusive of "extra materials" and "extra work," in accordance with the contract, during the preceding working month, and the value thereof figured at the unit prices contracted. Of the total amount so ascertained an amount equivalent to ten per centum (10%) of the whole will be retained by the Commission until after the completion of the entire contract and the balance, or a sum equivalent to ninety per centum (90%) of the whole, will be certified by the Commission to the State Board of Examiners for payment, except when such balance amounts to less than five hundred dollars ($500.00). In case where the ninety per centum (90%) of the amount earned during any one month shall be less than five hundred dollars ($500.00) no payment will be made, except on final estimate, until the ninety per centum (90%) of the total amount earned since the last preceding payment is at least five hundred dollars ($500.00).

9.8 Acceptance and Final Payment. Whenever the Contractor shall have completed the work in accordance with the terms of the Contract, the Engineer will make a final inspection of the work, and, upon completion of repairs, renewals and other work found to be necessary, he will certify to said completion and final acceptance, and will prepare the final estimate, including therein the amount and value of each class of work performed, including "extra work" and "extra materials." He will transmit to the Contractor a claim embodying said final estimate, and will notify the Contractor and his Surety of the acceptance of the contract. The accomplishment of the jurat on the final estimate claim by the Contractor shall constitute full acceptance by him of the total amount shown as entire payment of the amount due him under the contract, and by this action the Contractor shall be estopped from filing any claim whatever under the contract.

Upon return by the Contractor of the accomplished final estimate claim, same shall be certified by the Commission to the State Board of Examiners for payment, and payment thereof shall constitute, together with previous partial payments, full satisfaction for the total amount due under the contract. Erroneous or overpayments made by previous and partial payments shall be subject to correction in the final estimate.

STATE OF MONTANA

State Highway Commission

Standard Specifications
for
Highway Construction

DIVISION 2—CONSTRUCTION DETAILS
PART 1—EARTHWORK

ADOPTED JULY, 1931
REVISED OCTOBER, 1932
REVISED FEBRUARY, 1934
REVISED APRIL, 1935
HELENA, MONTANA

DIVISION 2—CONSTRUCTION DETAILS

PART 1—EARTHWORK

Description. Earthwork shall consist of clearing and grubbing, roadway and drainage excavation, excavation for structures, embankment, disposal of surplus material, borrow, overhaul, completion of subgrade and shoulders, subbase, finishing earth-graded roads, and earth cushion, all of which shall be done and paid for in accordance with these specifications.

SECTION 10.

CLEARING AND GRUBBING.

10.1 Description. Clearing and grubbing shall consist of clearing the ground of all trees, brush, rubbish, and other objectionable materials within the limits designated by the Engineer, and of grubbing the roadway, including borrow pits, within the limits for grubbing as designated by the Engineer.

10.2 Construction Methods. The right of way must be cleared on each side of the center line of the road to the full width indicated on the plans, or to greater width if necessary on account of curves or long slopes as directed by the Engineer. All trees, brush, and other vegetable matter within the space designated shall be cut down, and all tree branches extending into the right of way which hang within 20 feet of the ground shall be cut off close to the bole in a workmanlike manner. All stumps and all trees, the stumps of which are not to be grubbed, shall be cut not more than the diameter of the stump and in any instance not more than 2 feet above the ground.

From the space required for the roadbed and necessary slopes and side drains, except where embankments at the point in question are 3 feet or more in height, all stumps, large roots, and other embedded wood or vegetable matter, including duff, shall be grubbed or blasted from the grounds and removed.

All timber shall be felled in the right of way, and all trees, together with all brush, stumps, roots, duff, and other debris, must be placed in piles, in such a manner as to be completely consumed when the pile is burned. In case the burning is to precede the construction operations, the piles may be placed in the center of the right of way; otherwise the piles should be placed in the most convenient place to the side of the right of way and beyond fill slopes, where they may be burned without damage to the surrounding forest cover. In no case will it be permissible merely to throw the refuse outside of the right of way or to place it in windrows at the side of the right of way. The material placed in piles shall be burned by the Contractor, unless otherwise specified, at such time and in such manner as absolutely to prevent the fire from spreading to areas adjoining the right of way.

Trees of value to the appearance of the road and not coming within the slopes shall be left upon order of the Engineer, but all underbrush and debris shall be cleared out from around them. Payment for such work shall be the same as for other clearing above specified.

All portions of trees having a merchantable value shall be sawed into suitable log lengths and neatly piled along the road as directed by the Engineer and shall remain the property of the State.

10.3 Method of Measurement. (a) When no quantity of clearing or grubbing is shown in the proposal, no measurements for purpose of payment for any clearing or grubbing shall be made.

(b) If in the quantities shown in the proposal there is included an acreage of clearing or grubbing, then the acreage to be measured and paid for shall be the actual acreage cleared or grubbed and accepted as complete; the bounds for such acreage shall be established on the ground by actual staking or other equivalent means by the Engineer previous to the beginning of the work.

(c) If an item is included in the proposal calling for a lump sum price for all clearing and grubbing, then no measurements for purposes of payment shall be made other than those measurements necessary to determine whether or not the Contractor has actually cleared and grubbed the full width specified for clearing and grubbing.

10.4 Basis of Payment. (a) When no quantities of clearing or grubbing are shown in the proposal, and no lump sum bid for clearing and grubbing is called for, then no allowance whatever shall be made for any clearing or grubbing done on the project, but all clearing and grubbing as required in these specifications shall be done at the Contractor's own expense and shall be considered as subsidiary work pertaining to the items of roadway and drainage excavation and borrow.

(b) When an acreage of clearing or grubbing is shown in the proposal and a unit price per acre is called for, then the acreage measured as provided hereinbefore shall be paid for at the contract unit price per acre bid for "Clearing" or for "Grubbing."

(c) When a lump sum bid for all clearing and grubbing is called for in the proposal, the lump sum price so bid shall be full compensation for clearing the entire width of the right of way and for all grubbing within the limits of the construction slope stakes; also for all clearing and grubbing from such areas as may be required for off-take ditches, channel changes, borrow pits, etc.

Payment for clearing and grubbing as made under any of these methods of payment shall be full compensation for all labor, equipment, tools and incidentals necessary to complete the item or items.

SECTION 11.

ROADWAY AND DRAINAGE EXCAVATION.

11.1 Description. This work shall consist of excavating the roadway, the removal and satisfactory disposal of all materials taken from within the limits of the work, and shall include all excavation, shaping, and sloping necessary for the construction and preparation of the embankments, subgrade, shoulders, slopes, all gutters, ditches, intersections, approaches, and private entrances, as directed, to the required alignment, grade and cross section shown on the plans. The quantity of excavation as shown in the proposal form will be fifteen per cent in excess of the plan quantities in order to provide for possible overruns, but payment will be made only for the accepted yardage actually moved.

11.2 Classification. All materials of excavation for whatever purpose will be classified as follows:

(a) *Rock Excavation* shall include all ledge rock in place which cannot be excavated without drilling and blasting and boulders having a greater volume than one-half cubic yard.

(b) *Intermediate Excavation* shall include hardpan, shale, scoria, cemented gravel, boulders and stone measuring less than one-half (½) cubic yard and more than one (1) cubic foot in volume, and all other material of a rock nature or otherwise, that in the judgment of the Engineer cannot be plowed but may be loosened with a pick, although blasting may be resorted to in order to expedite the work.

(c) *Common Excavation* shall include all excavation material not otherwise classified.

(d) *Special Excavation.* When special excavation is called for in the proposal it shall be understood to include all material conforming to the classification for intermediate and common excavation.

(e) *Unclassified Excavation.* Unclassified excavation shall include any and all materials encountered during the construction of the work. This classification shall not apply where any of the material has been classified under any of the above classifications.

Excavated rock shall be used in forming embankments wherever the depth of fill is sufficient to properly contain the rock removed by excavation, and shall be placed in accordance with directions given by the Engineer. The Engineer may permit the Contractor to use excavated rock for purposes other than embankments, and in such case the Contractor shall furnish and place, at his own expense, an amount of borrow equal to the deficiency caused by the rock being used elsewhere, if it is found necessary to borrow material to bring any part of the road to grade.

11.3 Construction Methods. All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankment, sub-grade, shoulders, and at such other places as directed. No excavated material shall be wasted without permission, and when such material is to be wasted it shall be disposed of as directed by the Engineer. No payment will be made for any excavated material which is used for purposes other than those designated. During the construction of the roadway, the roadbed shall be maintained in such a condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments shall be so constructed as to avoid damage to embankments by erosion.

In cases where fences within the right of way limits interfere with construction operations, the Contractor shall take down such fences so as not to damage the material and deposit it in a neat manner at the edge of the right of way. The cost of removal of such fences shall be included in the unit price paid for excavation quantities.

Ditches shall be interpreted to mean roadway ditches, changes in channels of streams, ditches parallel to or adjacent to roadway, but beyond the limits of the roadway section as constructed, and inlet and outlet ditches to culverts and other structures. All roots, stumps, and other foreign matter in the sides and bottom of the ditch shall be cut to conform to the slope, grade, and shape of the section shown. The Contractor shall maintain and keep open and free from leaves, sticks, and other debris, all ditches dug by him until final acceptance of the contract.

The Contractor shall dispose of the excavated material as directed by the Engineer. The material excavated from all ditches and channel changes within 50 feet of the center line shall be placed in the embankments, or used for widening the same, when directed by the Engineer. No excavation, or spoil, from a ditch shall be deposited or left within 3 feet of the edge of the ditch, unless otherwise shown on the plans or directed by the Engineer in writing.

11.4 Method of Measurement. All accepted roadway and drainage excavation shall be measured in its original position by the method of average end areas, which measurements will include overbreakage or slides in common excavation, not attributable to carelessness of the Contractor, and authorized excavation of solid rock below grade, also of soft and spongy spots below grade. The measurement shall include unavoidable overbreakage in solid rock excavation to an amount not to exceed in any half station of 50 feet, 10 per cent of the actual quantity required for the same half station within the lines shown on the plans. The end areas will be obtained by combining an accurate cross section of the original ground line with the theoretical cross section of the completed work. Additional measurements will be taken to determine the volume of all overbreakage or slides not attributed to carelessness on the part of the Contractor and for all authorized borrow pits.

11.5 Basis of Payment. The yardage of roadway and drainage excavation, measured as provided above, shall be paid for at the contract unit price per cubic yard bid for unclassified excavation, special excavation, common excavation, intermediate excavation, or solid rock excavation, as the case may be, which price shall be full compensation for formation and compaction of embankments, disposal of surplus materials, preparation and completion of subgrade and shoulders, and the furnishing of all equipment, tools, labor, and incidentals necessary to complete the work.

SECTION 12.

EXCAVATION FOR STRUCTURES.

12.1 Description. This work shall consist of all excavation for foundations for culverts, bridges, and all other structures, and for excavation necessary for the removal of old culverts, and shall include the disposal of all material obtained from such excavation and back filling to the level of the original ground. It shall also include all necessary bailing, drainage, sheeting, and the construction of cribs or cofferdams if found necessary. The material shall be disposed of as directed by the Engineer and in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

12.2 Classification. All material excavated shall be unclassified and paid for as unclassified excavation for structures, unless otherwise provided in special provisions.

The excavation lines and bases of structures shown on the plans shall be considered as approximate only, and they may be ordered in writing by the Engineer to be placed at any elevation, or of any dimensions necessary to give a satisfactory foundation, and no additional compensation will be allowed for any such change except as provided under basis of payment.

Boulders, logs, or any unforeseen obstacles encountered in excavating shall be removed and no additional compensation will be allowed because of difficulties found in driving through or removing such obstructions.

All timber, sheeting, and other material used in making the excavation shall be removed except as ordered by the Engineer, and the cost of performing this work shall be considered as covered by the bid price for excavation.

12.3 Construction Methods. (a) *Depth.* All excavation shall be carried to depth of foundation materials satisfactory to the Engineer, regardless of the elevations shown on the plans, and unsuitable material shall be replaced with approved material if required. If rock bottom is secured, the excavation shall be done in such a manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the structure, except that for arch substructures, the bottom shall be sloped or stepped as directed by the Engineer. All rock or hardpan foundation surfaces shall be freed from loose or disintegrated pieces, thin strata shall be removed and the surfaces cut to firm bearing and cleaned to the satisfaction of the Engineer.

(b) *Treatment of Foundation Materials.* Where concrete or masonry is to be placed on any excavated surface, special care shall be taken not to disturb the bottom of the excavation more than necessary, and the final removal of the material to grade shall not be made until just before the concrete or masonry is laid. All seams or crevices shall be cleaned out and filled with concrete mortar. When the excavation is at the required depth, water if present shall be pumped out, if possible, for cleaning the foundation bed for inspection. The natural ground adjacent to the structure shall not be disturbed without permission of the Engineer. The existing ground surface at and adjacent to each unit of the substructure shall not be disturbed except as necessary for the sinking of the cofferdams, and all excavation shall be restricted to the area inside of the cofferdams, unless otherwise approved by the Engineer.

(c) *Cofferdams.* Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as water-tight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance and this shall be at the sole expense of the Contractor. Cofferdams shall be constructed so as to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry, without written permission of the Engineer.

When required by the Engineer, the Contractor shall submit drawings showing his proposed method of cofferdam construction and other details left open to his choice or not fully shown on the plans. Such drawings shall be approved by the Engineer before construction is started, but such approval shall not in any way relieve the Contractor of his responsibility to secure a safe and satisfactory cofferdam.

When conditions are encountered which, in the opinion of the Engineer, render it impracticable to unwater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation shall be pumped out and the balance of the masonry shall be placed in the dry. When weighted cribs are employed and the weight utilized to partly overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level.

Unless otherwise provided, cofferdams or cribs with all sheeting and bracing shall be removed by the Contractor after the completion of the substructure. The removal shall be effected in such a manner as not to disturb or mar the finished masonry.

(d) *Pumping.* Pumping from the interior of any foundation enclosure shall be done in such manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it be done from a suitable sump separated from the concrete work by a water-tight wall. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

(e) *Inspection.* After each excavation is completed, the Contractor shall notify the Engineer, and no masonry shall be placed until after the Engineer has approved the depth of the excavation and the character of the foundation material.

(f) *Backfilling.* All material used for backfill shall be of a quality acceptable to the Engineer and shall be free from large or frozen lumps, wood or other extraneous material. The backfill around drainage structures and approach grades to the same within 25 feet of the bridge, or such distance as the Engineer may direct, shall be made in continuous horizontal layers not more than 12 inches in thickness, each layer being tamped before the next layer is placed. Water shall be used to expedite settlement of the backfill only when it is difficult to compact the materials, and ordered by the Engineer.

All spaces excavated and not occupied by abutments, piers or other permanent work shall be refilled with earth up to the surface of the surrounding ground, with a sufficient allowance for settlement. All backfill shall be thoroughly compacted and, in general, its top surface shall be neatly graded.

The filling behind abutments and wing walls of all bridge structures shall be deposited in horizontal layers well compacted. Special precaution shall be taken to prevent any wedging action against the masonry, and the slope bounding the excavation for abutments and wing walls shall be destroyed by stepping or serrating to prevent wedge action.

Fills placed around culverts and piers and at the ends of the bridges with no superstructure expansion joints, shall be deposited on both sides at approximately the same elevation at the same time.

Adequate provision shall be made for thorough drainage of all backfilling. One-third of a cubic yard of coarse gravel or broken stone shall be placed at each drain in the wing and abutment walls. This work will be paid for as "Drains for Weep Holes" as hereinafter provided for in Section 48.

For foundations through hard material exposed to erosion, the backfill around piers and in front of abutments and wings may be ordered by the Engineer to be of stone or lean concrete, in which case, unless otherwise provided, this fill shall be paid for as extra work.

No backfill shall be placed against any masonry abutment, wing wall or culvert until permission shall have been given by the Engineer, and preferably not until the masonry has been in place twenty-one days.

(g) *Spandrel Fill.* The spandrel fill of arch bridges shall be composed of earth or gravel, and shall be placed in layers of variable thickness simultaneously over all piers, abutments and arch rings. At all points the ratio of thickness of each layer to the total depth of the proposed fill shall be approximately constant. The maximum thickness of any layer shall not exceed eighteen inches.

(h) *Approach Embankments.* When the contract for any bridge structure involves the placement of approach embankments, these shall be constructed and paid for in accordance with the Standard Specifications governing this class of work.

12.4 Methods of Measurement. The yardage to be paid for shall be the yardage measured in original position of the material actually removed as hereinbefore prescribed, except that no yardage will be included of excavation outside of a volume bounded by vertical surfaces, established at 12 inches outside the neat footings.

12.5 Basis of Payment. Payment for all work prescribed under this item and measured as provided above shall be made at the contract unit price bid per cubic yard for unclassified excavation for structures, which price shall be full compensation for furnishing all material, for all labor, equipment, tools and incidentals necessary to complete the work; provided that in the case of bridges when it is found necessary to carry footings more than three feet below the elevation shown on the plans, such excavation shall be paid for as extra work, unless the price for excavation at various depths is called for in the proposal.

SECTION 13.

EMBANKMENT.

13.1 Construction Methods. Embankments shall be formed of suitable material. Where the method of construction will permit, the material shall be placed in successive layers and not more than 12 inches in depth for the full width of the cross section. Where rock is being used in the embankment it shall be carefully distributed, and the interstices filled with earth or finer particles to form a dense, compact mass. Written permission from the Engineer must be secured before trestles may be used in the construction of embankments, and when trestles are so used and left in place they must be cut two feet below subgrade.

Embankments shall be formed of suitable material; stumps, trees, rubbish, sod, frozen or other unsuitable materials or substances shall not be placed in the embankment. When embankments are to be made on a hillside, of such nature that will, in the opinion of the Engineer, preclude a proper bond between the old and new materials, the slope of the original ground on which the embankment is to be placed shall be plowed deeply or cut into steps before the filling is commenced. Otherwise,

before any embankment is placed on smooth firm surface, and with particular reference to the construction of shallow fills placed on existing roadbed, the original ground shall be scarified or plowed so as to permit bonding the new with the existing material. In every case embankments must be built the full width of the cross section. If a power shovel, drag line, or elevating grader is used to cast side borrow directly on to an embankment, such casting must cover the full width between slope stakes, or must be spread in layers not more than 12 inches in depth for the full width of the cross section.

The Contractor will be required by the Engineer to construct embankments so that, after shrinkage and settlement are complete, all embankments shall have the required grade and cross section at all points. If at any time before the final acceptance of the project, the embankment settles or shrinks below the staked grade, it shall be brought back to the staked grade by the Contractor at the unit prices bid for excavation.

13.2 Compensation. Embankment will not be measured or paid for directly. It shall be considered a necessary part of the work paid for as unclassified excavation, special excavation, common excavation, intermediate excavation, solid rock excavation, excavation for structures, or borrow, as the case may be. The cost of plowing hillsides or scarifying old roadbeds shall be included in the price bid for excavation.

SECTION 14.

DISPOSAL OF SURPLUS MATERIAL.

All surplus excavation and waste material shall be used to widen embankments uniformly or to flatten slopes, or shall be deposited in such other places and for such purposes as the Engineer may direct. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the Engineer. The Contractor shall not borrow and waste without written application to and written consent from the Engineer. Under no circumstances shall he be paid for excavation beyond the established line of the roadway prism, or for borrow, when such excavation or borrow results from the method of borrow and waste, nor for overhaul not actually required by the design. The work described under this item will not be measured or paid for directly. It shall be considered a necessary part of the work for unclassified excavation, special excavation, solid rock excavation, intermediate excavation, excavation for structures, or common excavation, as the case may be.

SECTION 15.

BORROW.

15.1 Description. Borrow shall consist of excavation, and disposal as directed, of satisfactory material obtained from borrow pits designated, staked, and measured by the Engineer. Borrow shall be used when sufficient quantities of suitable materials are not available from the roadway, structure and drainage excavation to properly form the embankment, subgrade, shoulders, and to complete the back filling of structures. Where conditions are favorable, borrow pits in cuts to widen the roadway shall be designated by the Engineer.

15.2 Construction Methods. The Contractor shall notify the Engineer sufficiently in advance of the opening of any borrow pit so that elevations and measurements of the existing ground surface may be taken. All borrow pits shall be neatly trimmed, and left in such shape as to admit of accurate measurement after the excavation is completed. Where practicable they shall be so excavated that no water will collect or stand therein.

15.3 Method of Measurement and Basis of Payment. Borrow shall be measured in its original position by the method of average end areas. The yardage so measured shall be paid for at the contract price per cubic yard bid for unclassified excavation, special excavation, rock excavation, intermediate excavation, or common excavation, provided, however that no payment whatever will be allowed the Contractor for any material excavated from borrow pits or elsewhere prior to the staking out and cross sectioning of the work by the Engineer, and rock excavation will not be allowed unless ordered in writing by the Engineer.

SECTION 16.

OVERHAUL.

16.1 Description and Method of Measurement. When, in constructing embankments as directed, excavated or borrow material is hauled more than 500 feet, overhaul will be allowed on such material. The overhaul distance will be the distance between the centers of volume of the overhauled material in its original position and after placing, less 500 feet. The distance shall be measured along the shortest practicable route. The number of station yards of overhaul shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in feet, divided by 100.

16.2 Basis of Payment. Overhaul will be paid for at the unit price per station yard bid for overhaul.

SECTION 17.

SUBGRADE.

17.1 Description. After the earthwork has been substantially completed and after all drains have been laid, the subgrade shall be brought to the lines, grades, and cross sections shown on the plans. Subgrade rolling will not be required unless prescribed in special provisions.

17.2 Construction Methods. All soft and unstable material and other portions of the subgrade which will not compact readily shall be removed as directed. All boulders appearing in the earth excavation shall be removed or broken off to a depth to not less than 4 inches below the subgrade. All holes or depressions shall be filled with approved material and the subgrade brought to line and grade and compacted; this material shall be obtained as excavation or borrow and paid for as such unless otherwise directed in writing. All rock sections shall be brought to grade by depositing a satisfactory cushion material to the depth authorized by the Engineer.

If the surface of an old stone or gravel roadbed conforms approximately to the surface of the finished subgrade at sections where reconstructed base course is not proposed, such sections shall be scarified superficially as directed to a uniform depth below and for the full width of the subgrade to a depth just sufficient to eliminate all depressions and to permit of uniform reshaping.

All intersecting public highways shall be graded as shown on the plans or as directed by the Engineer, and acceptable materials used on the surface so that a commodious, smooth-riding, and satisfactory intersection shall be produced.

At all times ditches and drains along the subgrade shall be so maintained as to drain it effectively. When ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade, and if necessary be reshaped and rerolled. In no case shall any surface course or pavement be placed on a frozen or muddy subgrade. Until the subgrade has been checked and approved, no surface course or pavement shall be laid thereon.

17.3 Compensation. Subgrade work shall not be measured or paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation, special excavation, common excavation, intermediate excavation, rock excavation, excavation for structures or borrow, except cushion material for covering rock and boulder subgrade which will be paid for as hereinafter specified, in Article 21.4.

SECTION 18.

SHOULDERS.

18.1 Description. After the earthwork has been substantially completed, and after all drains have been laid, the shoulders shall be constructed of approved material to the elevation and shape shown on the plans, and after surface course or pavement is completed, dressed as directed to the full width of the roadbed.

18.2 Construction Methods. Before any subgrade shall be approved the adjacent shoulders shall be

constructed to the full width and at least to the level of the finished subgrade, but not necessarily to the final height and shape. In all cases where subgrade rolling is required, it shall be extended onto the shoulders for a distance of at least 1 foot outside the pavement or surface course. At all times construction shall be so carried on that the subgrade, shoulders, and adjacent ditches will be effectively and completely drained. When the surface course or pavement is completed the shoulders shall be shaped and dressed, as directed, to the lines, elevations, and cross section shown on the plans. This work shall be done in proper sequence with the surface course or pavement construction as directed.

18.3 Basis of Payment. This work shall not be measured or paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation, special excavation, intermediate excavation, rock excavation, excavation for structures, common excavation and borrow or surfacing and pavement.

SECTION 19.

GRAVEL SUB-BASE.

19.1 Description. This item shall consist of a single course of gravel sub-base material constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades and thickness shown on the plans or designated by the Engineer.

19.2 Material. The material shall consist of a hard durable gravel uniformly graded between the following limits:

Passing a Screen with 3½-inch circular openings	100%
Passing a Screen with ¼-inch circular openings	25 to 60%
Clay not more than	15%

19.3 Construction Methods. Upon the prepared sub-grade approved by the Engineer, the Contractor shall spread the gravel sub-base material to the lines, grades and thickness shown on the plans or designated by the Engineer. If the material in the pit contains more than five per cent (5%) of oversize material, the oversize material shall be removed by passing the gravel through a screen or grizzly at the pit. If the pit run material contains less than five per cent (5%) of oversize material, screening will not be required providing the Contractor forks or rakes all oversize material from the roadway and disposes of it as directed by the Engineer. Special care shall be taken to prevent the segregation of fine and coarse material. The final shaping and finishing shall be done with a grader weighing not less than 5,600 pounds.

19.4 Method of Measurement. Gravel sub-base material shall be measured by the cubic yard loose measurement in the vehicle at the point of delivery on the road. A deduction shall be made for the amount of oversize material which it may be necessary to remove from the roadway.

19.5 Basis of Payment. Gravel sub-base material shall be paid for at the contract unit price bid per cubic yard complete in place, which price shall be full compensation for furnishing, loading, hauling, spreading, and shaping all materials and for all equipment, tools, labor, and incidentals necessary to complete the work.

SECTION 20.

FINISHING EARTH-GRADED ROADS.

20.1 Description. This item shall consist of the final finish ready for traffic of the roadbed where an earth-graded road without surfacing other than earth or selected material is proposed; the work shall consist of shaping and dressing the roadbed to conform to the lines, grades, and typical cross section shown on the plans.

20.2 Construction Methods. After all earthwork has been substantially completed, all structures are complete, and all drains laid, the entire surface of the roadbed shall receive a finish shaping with grading machine, supplemented by hand work where necessary to secure a smooth surface and uniform cross section. All rock sections and all other sections where the natural material is not deemed suitable by the Engineer shall be brought to grade by depositing to the depth authorized by the Engineer a satisfactory cushion of selected material. The entire roadbed shall be brought to the final elevation and shape indicated on the plans and dressed as directed by the Engineer. No roots, sod

or other deleterious matter, or stones that would fail to pass a 3½-inch ring shall be left within the top 4 inches of the finished road surface.

In order to secure a smooth, even surface to the finished grade, the Contractor building the grade shall provide and use a grader weighing not less than 5,600 pounds, with sufficient tractor power for its efficient operation.

20.3 Basis of Payment. Cost of finishing shall be included in the unit prices bid for excavation, except cushion material which will be paid for as hereinafter specified in Article 21.4.

SECTION 21.

EARTH CUSHION MATERIAL.

21.1 Description. This item will consist of the placing of a satisfactory covering of earth or fine gravel upon those sections of the project where the subgrade is composed of rock or boulders.

21.2 Material and Method of Construction. The material used shall consist of suitable earth or gravel. If gravel is used, it shall contain no stones which will not pass a screen having two-inch circular openings. The material shall be obtained from pits approved by the Engineer, hauled and evenly spread to such depth as will completely cover all boulders or projecting rock. Where the material is hauled for a distance in excess of one mile, overhaul will be allowed on such material.

21.3 Method of Measurement. Cushion material will be measured by the cubic yard in its original position. Haul will be measured by the cubic-yard mile, the distance for which overhaul is allowed being the distance, in miles, between the centers of volume of the overhauled material in its original position and after placing, less one mile. The number of cubic yard-miles of overhaul shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in miles.

21.4 Basis of Payment. Payment will be made for the following items:

Earth Cushion Material in place, including all haul within one mile, per cubic yard.

Overhaul on Earth Cushion Material hauled over one mile, per cubic yard-mile.

These bid prices shall be full compensation for furnishing, loading, hauling, and spreading all material, and for all equipment, tools, labor, and incidentals necessary to complete the work.

STATE OF MONTANA

State Highway Commission

Standard Specifications
for
Highway Construction

DIVISION 2—CONSTRUCTION DETAILS
PART 2—SURFACE COURSES

ADOPTED JULY, 1931
REVISED OCTOBER, 1932
REVISED FEBRUARY, 1934
REVISED APRIL, 1935
HELENA, MONTANA

DIVISION 2—CONSTRUCTION DETAILS

PART 2—SURFACE COURSES

SECTION 22.

CRUSHED ROCK OR CRUSHED GRAVEL SURFACE COURSES.

22.1 Description. This item shall consist of one or two courses, as indicated on the typical cross section, composed of crusher-run rock or gravel and binder, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans.

22.2 Materials. The material for this work shall be crushed from sound, tough durable rock or gravel and shall be uniform in quality and grading. When tested by means of laboratory screens, it shall meet the following requirements:

Base Course.

Passing a screen with 1¼-inch circular openings	100%
Retained on a screen with ¼-inch circular openings	50% to 75%

Top Course.

Grade A:

When tested for grading by laboratory methods, aggregate, prepared ready for bituminizing including all blended constituents, shall meet the following grading requirements:

MASTER GRADATION TABLE

Size	Grade "A" Per Cent
Passing a ¾-inch screen (circular)	100
Passing a ¼-inch screen (circular)	40–65
Passing a 10-mesh sieve	30–55
Passing a 40-mesh sieve	15–35
Passing a 200-mesh sieve	5–15

The material passing the 40-mesh sieve shall not have a field moisture equivalent in excess of 20 per cent, nor a lineal shrinkage of more than 2 per cent.

For closer control of the fractions passing the ¼-inch screen, 10-mesh and 200-mesh sieves, the aggregate, blended if blending is involved, shall be of a uniformity within any "run" such that the proportions of any one of these gradation fractions in the several samples taken within the "run" will not vary from the maximum to minimum more than the amounts tabulated below.

GRADATION FOR ANY ONE "RUN"
Allowable Variations Within "Run"
(Maximum to Minimum)

	Per Cent
Material passing a ¼-inch screen	10
Material passing a 10-mesh sieve	10
Material passing a 200-mesh sieve	5

No bituminous material shall be applied on any "run" until sieve analyses of these samples have been made, the average analysis of the "run" and the consequent proportion of bitumen, both duly determined, and the "run" approved. A "run" shall be construed as that length of road or construction lane, less than the daily capacity of one mixing outfit, set by the Engineer as a convenient unit.

Grade B:

Passing a screen having ¾-inch circular openings	100%
Retained on a screen having ¼-inch circular openings	50% to 75%

The fine aggregate (that passing a ¼-inch screen) in Grade "B" surfacing material may contain such a quantity of clay that the percentage of clay in the entire mass of surface material shall not exceed 15 per cent.

Wherever the size of material is mentioned in these specifications, it shall be understood that such size is based on circular openings. The Contractor's gravel plant shall be equipped with screens having circular openings not exceeding the maximum permissible size of the material, or he may substitute a screen having one (1) inch square openings for the one and one-quarter (1¼) inch circular size and a screen having five-eighths (⅝) inch square openings for the three-quarters (¾) inch circular size.

All that portion of the natural gravel encountered in the deposit which is not too large to be handled by an approved type of crusher, shall be passed through one or more crushers and thereby crushed to conform to the maximum size specified above, except that: The Contractor may install an auxiliary screen or grizzly which will temporarily remove the sand and pebbles not larger than three-quarters (¾) inch in size when running top course material and not larger than one and one-quarter (1¼) inch in size when running base course material, passing this fine material around, rather than through, the crusher; but under this circumstance the fine material shall not be wasted and it shall eventually find its way through the screens to the bins. The Contractor will not be permitted to select relatively small gravel and disregard the larger particles in order to avoid crushing, except in respect to such oversize material as cannot be properly crushed by the crusher or crushers provided. The purpose of this specification is to provide for a maximum percentage of crushed particles in the surfacing material.

In general, acceptable surfacing material will consist of the crusher-run product as above described. However, in the event that an excess of fine material is produced, the Contractor may be required to remove such excess of fine material at the plant before crushing. On the other hand, if a deficiency of fine material is produced, or when such fine material is lacking in cementing value or is otherwise unsuitable, the Contractor may be required to furnish and add at the plant additional fine material of acceptable quality; and no such fine material shall be added without the written authorization of the Engineer.

The Engineer may fix the maximum per cent of the surfacing material passing the ¼-inch screen, within the above limits, and the Contractor will not be allowed any claim for payment for cost of rejection of fines to conform to such maximum limit.

22.3 Construction Methods. The crushed rock or crushed gravel for each course shall be spread evenly upon the subgrade prepared in accordance with the requirements of Section 17, or upon the completed preceding surface course, to the width and thickness shown on the plans. All holes, ruts, defects or soft places occurring in the subgrade because of traffic or hauling over the same, or from any other cause shall be corrected before surfacing materials are placed on the road. Surfacing material shall not be placed upon a muddy subgrade. Unless otherwise authorized by the Engineer, at least one mile of completely finished earth graded road shall be kept in advance of the placing of any surface course.

In addition to the restrictions imposed by state laws on the speed, size, and weight of vehicles, weight of loads, and tire equipment (see Section 1742 of the Revised Codes of Montana of 1921 and Chapter 171 of the Twenty-second Legislative Session Laws of Montana, 1931) the Engineer may further restrict the speed of the hauling units and the weight of loads as he may deem necessary to prevent damage to the subgrade or to previously constructed surface course or courses.

The mixing, shaping and maintenance of the surface courses shall be done with a grader weighing not less than 5,600 pounds with a sufficient tractor power for its efficient operation. The material shall be spread and thoroughly mixed by alternately blading the material into windrows in the middle and back to the edges of the subgrade until the material is uniform throughout. In general two complete movements of the material entirely across the roadway will be sufficient. Harrowing will not be required, but the Contractor must observe that merely spreading the material without properly mixing it will not meet the requirements of this provision, the purpose of which is to secure the nearest practical approach to a mass of uniform mixture and density, spread to the proper thickness.

The work shall begin at the point nearest the point of supply. Hauling shall be done over the surfacing material already deposited to compact it, accompanied by constant blading and dragging, care being taken to fill all ruts caused by hauling, to prevent the formation of corrugations and waves in the longitudinal profile of the surface course, and to avoid the segregation of the material into non-uniform layers or patches of coarse or fine material. Should the surface become uneven or distorted and set up in that condition, the Contractor shall break the surface thoroughly by scarifying and shall reshape it to a smooth and even section. The placing of the top course material shall not be started until after the base course has been thoroughly compacted.

If the roadway being surfaced is under traffic, the Contractor shall spread the surfacing material uniformly over the surface immediately after it is deposited. If the section is not under traffic, the material shall be spread, mixed and shaped after each day's run. The entire length of the surfaced section shall be bladed or dragged at least once each day while work is in progress and until the final completion and acceptance of the section.

22.4 **Binder.** If in the judgment of the Engineer the fine aggregate is deficient in binding quality, an approved quantity of binder material shall be added to the surface mixture, provided, however, that the grading of the entire mass of surfacing material, including the added binder, shall not exceed the limits specified in Article 22.2. Binder used with Grade "A" Top Course Material shall consist of stone dust, iron oxide, disintegrated granite or other inorganic material excepting clay, adobe, or other material having a high moisture equivalent or shrinkage factor. The source of supply for binder material shall be designated by the Engineer, and the Commission will furnish the material in its original position without expense to the Contractor except in cases where the material can be obtained within a distance of five hundred feet of the Contractor's crusher and is added at the plant, in which case the additional binder shall be considered an integral part of the surfacing material and must be supplied by the Contractor without additional cost to the Commission.

When additional binder is required after the surfacing material is placed on the road, it shall be uniformly spread in the amount specified by the Engineer. It shall be thoroughly mixed with the surfacing material by the means specified herebefore for mixing the surfacing material.

When additional binder is hauled for a distance in excess of five hundred feet, overhaul will be allowed on such material.

22.5 **Watering.** If the surfacing material is too dry to secure a proper compaction, watering may be resorted to. The sprinkler or other spreading device shall be of such a type as to provide a uniform distribution of the water without producing any noticeable washing effect upon the surfacing material and it shall be approved by the Engineer prior to use. A water plant shall not be furnished nor used unless ordered in writing by the Engineer and the amount of water used shall be as directed by the Engineer.

22.6 **Rolling.** In general the compaction of the surface courses will be obtained under traffic. In case a more thorough or more rapid compaction is desired by the Engineer than that which can be obtained by traffic, the Contractor shall roll the surface course or courses while they are still wet. The rolling shall be done with a self-propelled tandem type roller weighing not less than six (6) tons or with a self-propelled three-wheel type roller weighing not less than ten (10) tons. Rolling shall commence at the side and progress towards the center, overlapping at each succeeding passage, and continuing until there is no appreciable waving or creeping of the material ahead of the roller. A roller shall not be furnished nor used on a project unless authorized in writing by the Engineer, and the amount of rolling shall be controlled exclusively by the Engineer.

22.7 **Stock Piled Gravel.** During the progress of surfacing operations, the Contractor shall furnish, deliver and place crushed gravel or crushed rock surfacing material for future maintenance purposes in stock piles at such places along the work as the Engineer may direct. The material shall conform to the specifications for top course crushed gravel or crushed rock surfacing material of the same grade as the material placed on the road or specified in the proposal form or special provisions. Unless otherwise specified in special provisions, the stock piles will be approximately uniform in size and located at uniform intervals along the work. The piles will be so placed that the average yard-mile haul to the stock piles will not exceed the average yard-mile haul of the material placed on the adjacent roadbed. Previous to placing the stock piles, the area they are to cover shall be cleared of weeds, roots, stumps, rocks and any other obstructions which might foul the material or hinder later loading operations. The piles shall be shaped and constructed as directed by the Engineer and in general shall occupy the least practicable surface area.

22.8 **Methods of Measurement.** (a) Top and base course crushed gravel or crushed rock surfacing material shall be measured by the cubic yard or by the ton of 2,000 pounds as called for in the Proposal Form. If measured by the cubic yard, the measurement shall be made of the loose material in the vehicle at the point of delivery on the road, and in order to aid in the checking of loads, the Contractor shall strike or level any load when ordered to do so by the Inspector.

If measured by the ton, the material shall be weighed on scales furnished by and at the expense of the Contractor. The scales shall be satisfactory to the Engineer and shall be tested and sealed at the expense of the Contractor as often as the Engineer may deem necessary to insure their accuracy.

(b) Binder which is added after the surfacing material has been placed upon the road shall be measured by the cubic yard in its original position.

(c) Overhaul on binder shall be measured by the yard-mile. The overhaul distance will be the distance between the centers of gravity of the overhauled material in its original position and after placing, less 500 feet. The distance shall be measured along the shortest practicable route. The number of yard-miles of overhaul shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance measured in miles.

(d) Watering, if required, shall be measured by the 1,000 U. S. gallons.

(e) Rolling, if required, shall be measured by the hour of time actually engaged in rolling the surface. Time lost in making repairs or for other reasons and time used in moving to and from the work shall not be measured or paid for.

(f) Stock piled gravel shall be measured according to the method used in measuring the top and base course crushed gravel or crushed rock surfacing material; except that in case a stock pile is in such a close proximity to the crushing plant that loading and hauling is not required, then the material shall be measured by the cubic yard in the completed stock pile by actual cross-sectional measurements of the stock pile with no allowance being made for shrinkage or compaction.

22.9 Basis of Payment. The completed and accepted surface course or courses shall be paid for at the contract unit bid prices for such of the following items as are required to complete the work:

(a) Crushed gravel or crushed rock surfacing material in top course, per cubic yard or per ton as called for in the Proposal Form.

(b) Crushed gravel or crushed rock surfacing material in base course, per cubic yard or per ton as called for in the Proposal Form.

(c) Binder, when added to the surfacing material on the roadway, per cubic yard.

(d) Overhaul on binder hauled over 500 lin. ft., per yard-mile.

(e) Providing and maintaining a water plant on the project, lump sum.

(f) Watering, as required, per 1,000 gallons.

(g) Providing and maintaining a roller upon the project, lump sum.

(h) Rolling, as required, per hour.

(i) Stock piled gravel, per cubic yard or per ton as called for in the Proposal Form.

These bid prices shall be full compensation for furnishing, (except as noted for binder in Article 22.4) hauling, and placing all material complete in place, and for all equipment, tools, labor, and incidentals necessary to complete the work.

NOTE. All gravel or rock shall be furnished by the Contractor, who shall assume responsibility for the quality and sufficiency of the deposit or deposits. The Commission will investigate the several sources of gravel or rock supply, and the results of such investigation will be available to the Contractor.

OIL TREATED CRUSHED ROCK OR CRUSHED GRAVEL SURFACE COURSE.

SECTION 23.

ROAD MIX TREATMENT.

23.1 Description. The road mix oil treated surface course shall consist of a mixture of crushed rock or crushed gravel and asphaltic road oil prepared on the roadbed by mechanically mixing the oil and surfacing material and spreading and compacting the mixture to the width, thickness, and typical cross section shown on the plans.

23.3 Materials. (a) The crushed rock or crushed gravel shall conform to the requirements for Grade "A" top course surfacing materials as specified in Article 22.2.

(b) *Oil.* The oil shall meet the following requirements for physical and chemical properties:

SLOW CURING PRODUCTS—ROAD OILS

Specification Designation..... General Requirement: The material shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.	Test Method (ASTM)	SC-1	SC-1A	SC-2	SC-3	SC-4	Asphaltic Road Mat'l. 95+
Asphaltic Residue of 50 Penetration	D 243-26T	30-35%	50% Min.	65% Min.	71% Min.	76% Min.	95% Min.
Ductility, of 50 Pen. Residue at 77° F.....	D 113-32T	.....	100+ cm.	100+ cm.	100+ cm.	100+ cm.	.....
Water and Sediment, %	D 96-30	2% Max.	2% Max.	2% Max.	2% Max.	2% Max.	
Water %	D 96-30						0.5% Max.
Sediment %	D 96-30						1.0% Max.
Flash Point, Cleveland Open Cup	D 92-33	150°F. Min.	175°F. Min.	200°F. Min.	200°F. Min.	250°F. Min.	400°F. Min.
Viscosity, Saybolt Furol, @ 77°F. Sec's.	D 88-33	*20-40					
Viscosity, Saybolt Furol, @ 122°F. Sec's.	D 88-33		40-80	200-320			
Viscosity, Saybolt Furol, @ 140°F. Sec's.	D 88-33				150-300	350-550	
Viscosity Float Test @ 77°F. Sec's.	D 139-27			200 Max.	250 Max.		
Viscosity Float Test @ 122°F. Sec's.	D 139-27						250 Min.
Penetration of Residue after loss on heating @ 325°F. for 5 hours	D 6-33						125 Min.
Distillation, % by volume.....	D 402-34T						
Total Distillate to 437°F.....			3% Max.	2% Max.	2% Max.	2% Max.	
Total Distillate to 600°F.....			25% Max.	15% Max.	10% Max.	8% Max.	
Total Distillate to 680°F.....		50% Max.	30% Max.	25% Max.	20% Max.	18% Max.	
Tests of Residue from Distillation: Float Test @ 122°F. Sec's.	D 139-27	50 Max.	50 Max.	25 Min.	25 Min.	25 Min.	
Bitumen (Sol'b. in Carbon Disulfide)	D 4-27	99.0% Min.	99.0% Min.	99.0% Min.	99.0% Min.	99.0% Min.	99.0% Min.
Proportion of Bitumen soluble in carbon tetrachloride	D 165-27	99.65% Min.	99.65% Min.	99.65% Min.	99.65% Min.	99.65% Min.	99.65% Min.
Temperature at which applied		150-250°F.	175-300°F.	175-300°F.	200-325°F.	200-325°F.	275-450°F.

* Asphalt Institute specifies viscosity @ 77°F. of 20 to 150 seconds for other than Western States.

NOTE:—No bituminous material will be allowed to be used until tests have been completed and the material approved by the State Highway Commission Laboratory.

MEDIUM CURING KEROSENE CUT-BACK ASPHALTS

Specification Designation..... General Requirement: The material shall be free from water and shall meet the following requirements when tested in accordance with the methods hereinafter enumerated.	Test Method (ASTM)	MC-1	MC-2	MC-3	MC-4	MC-5
Flash Point, Tag Open Cup*	*		150°F. Min.	150°F. Min.	150°F. Min	150°F. Min.
Viscosity, Saybolt Furol, @ 77°F. Sec's.	D 88-33	40-150				
Viscosity, Saybolt Furol, @ 140°F. Sec's.	D 88-33		150-250	300-500	500-800	
Viscosity, Saybolt Furol, @ 180°F. Sec's.	D 88-33					170-280
Distillation, per cent by volume	D 402-34T					
Total Distillate to 437°F.....		10% Max.	2% Max.	2% Max.	1% Max.	1% Max.
Total Distillate to 600°F.....		25% Min.	10-20%	8-20%	16% Max.	14% Max.
Total Distillate to 680°F.....		50% Max.	27% Max.	25% Max.	25% Max.	20% Max.
Tests of Residue From Distillation: Penetration: 100g. 5 sec. 77°F.	D 5-25	70-300	100-300	100-300	100-300	100-300
Ductility @ 77°F.	D 113-32T	60 cm Min.	60 cm Min.	60 cm Min.	60 cm Min.	60 cm Min.
Bitumen (Soluble in carbon disulfide)	D 4-27	99.5% Min.	99.5% Min.	99.5% Min.	99.5% Min.	99.5% Min.
Proportion of Bitumen soluble in carbon tetrachloride	D 165-27	99.65% Min.	99.65% Min.	99.65% Min.	99.65% Min.	99.65% Min.
Application temperature, degrees F.		180-250	180-250	180-250	180-250	180-250

* Method outlined by the U. S. Bureau of Public Roads.

NOTE:—No bituminous material will be allowed to be used until tests have been completed and the material approved by the State Highway Commission Laboratory.

Specification Designation	Test Method (ASTM)	RC-1 Extra Light	RC-2	RC-3	RC-4
General Requirement: The material shall be free from water and shall meet the following requirements when tested in accordance with the methods hereinafter enumerated					
Flash Point, Tag Open Cup*		80°F. Min.	80°F. Min	80°F. Min.	80°F. Min.
Viscosity, Saybolt Furol, @ 77°F. Sec's.	D 88-33	150-300			
Viscosity, Saybolt Furol, @ 122°F. Sec's.	D 88-33		200-400		
Viscosity, Saybolt Furol, @ 140°F. Sec's.	D 88-33			275-400	700-1400
Distillation, % by volume:	D 402-34T				
Total Distillate to 374°F.		8% Min.			
Total Distillate to 437°F.		25% Min.	10% Min.	3% Min.	0.5% Min.
Total Distillate to 600°F.		35% Min.	20% Min.	14% Min.	7.0% Min.
Total Distillate to 680°F.		40% Max.	35% Max.	23% Max.	15.0% Max.
Tests of Residue from Distillation:					
Penetration: 100g. 5 sec. 77°F.	D 5-25	50-80	60-120	60-120	60-120
Ductility @ 77°F.	D 113-32T	100 cm Min.	70 cm Min.	70 cm Min.	70 cm Min.
Bitumen (Sol'b. in Carbon Bisulfide)	D 4-27	99.5% Min.	99.5% Min.	99.5% Min.	99.5% Min.
Proportion of Bitumen Soluble in carbon tetrachloride	D 165-27	99.65% Min.	99.65% Min.	99.65% Min.	99.65% Mnl.
Temperature at which applied		50-125°F.	150-225°F.	175-250°F.	200-250°F.

* Method outlined by the U. S. Bureau of Public Roads.

NOTE:—No bituminous material will be allowed to be used until tests have been completed and the material approved by the State Highway Commission Laboratory.

(c) *Type and Grade of Oil to Be Used.* The type and grade of oil to be used in each operation shall be specified by the State Highway Commission in the proposal form or in special provision attached thereto.

(d) *Test Reports.* A certified report shall be furnished in duplicate at the time of shipment of each carload of oil, the original to be mailed to the Testing Laboratory at Helena and the duplicate to be mailed to the consignee.

The report shall contain the following information:

1. Date of shipment.
2. Car intial and number.
3. Destination.
4. Quantity contained in car.
5. Grade.
6. Specific Gravity.
7. Asphaltic Content.
8. Viscosity.

23.3 **Construction Methods.** The existing road surface shall be scarified or bladed to a depth parallel to the finished surface, which scarifying or blading or both will produce the quantity of loose material required to make the compacted thickness of oil mixed surface shown on the plans. It is assumed in this work that sufficient top material exists on the entire road surface to assure the loosening of the amount of material required; however, in no case will the Contractor be allowed to scarify or otherwise loosen the base course. In case sufficient top material is not on the road to allow for the quantity of loose material necessary for the thickness of mat shown, the Engineer shall have additional material hauled on the thin section. Any additional material hauled will be done by state forces or paid for as extra work. In case the Contractor loosens more surface material than is necessary to produce the thickness of mat as shown on the plans the entire mass shall be oiled and mixed and the Contractor shall stand for all costs including that of additional oil necessary in excess of the plan amount.

The amount of asphaltic oil required shall be estimated by the Engineer from day to day. The oil shall be spread under a pressure at a temperature within the limits specified in Article 23.2 (b) and

at an atmospheric temperature of not less than 65°F. The oil shall be applied in not less than three applications.

After the last oil application and partial mixing the entire mass of top course material shall be moved by a heavy blade grader into a windrow; and then the windrow shall be moved from side to side of the roadway with a revolving motion until all particles of road metal are covered with oil and the whole mass has a uniform color. At least 10 moves of the material as above described will be required, under the most favorable conditions of air temperature, material grading, efficiency of equipment, and skillful workmanship. A move shall be understood to consist of the movement of the entire mass from one edge of the proposed oiled section to the other. Under conditions less favorable for effective mixing, as many more turns will be required as necessary to produce the desired uniformity of mixture.

In lieu of mixing the material as above specified, any equipment other than that required above, may be employed which will produce a complete mixture equal to that which would be produced by the means above specified. The Commission reserves the right to order the use of any equipment discontinued which, in the opinion of the Engineer, fails to produce a satisfactory mixture.

After the mixing operation is completed, the windrows shall be examined to determine if the oil content is correct. The color must be brown rather than black. In case of doubt, the stain test shall be applied. If the proportion of oil is excessive, additional uncoated material shall be loosened from the floor or shall be hauled on the moist section at the option of the Engineer and shall be thoroughly mixed with the original mass by blading. If more oil is required, a portion of the mixed material shall be spread upon one side of the roadway, the required additional oil distributed thereon and the mixing resumed until uniformity is secured.

After the road metal has been mixed with the required amount of oil, the mixture shall be spread to uniform thickness by a rubber tired grading unit having a wheel base of not less than 16 feet, and shall be allowed to compact under traffic. During the compaction process, the blade grader or a heavy road planer at least 16 feet long shall be operated to fill ruts and remove other irregularities.

If fat spots develop under traffic during compaction, the area shall be scarified and sufficient uncoated material incorporated to produce a satisfactory mixture. If lean spots develop, additional oil shall be applied and such spots remixed to the full depth until uniformly coated.

Wet Weather: The moisture content of the mineral aggregate at the time the oil is applied shall not exceed two per cent (2%). If rain commences to fall during the oiling or mixing operation, the treated material shall be windrowed promptly. The treated material and the base shall then be allowed to dry before the resumption of any work except such turning as will facilitate evaporation.

The Engineer shall be the sole judge as to when the roadbed has dried sufficiently to allow the work to be resumed.

Any oversize which may enter the mix, regardless of its origination, shall be forked from the roadway during the progress of the mixing at the Contractor's expense. Oversize shall be understood to be any foreign material or any rock which will not pass a 1½-inch circular opening.

The Contractor shall recondition at his expense, any damage done to the highway or structures due to the operation of his equipment or caused by traffic being forced away from the usual lines of travel.

Any defects, such as ravelling, low centers, lack of uniformity or other imperfections caused by faulty workmanship shall be corrected to the satisfaction of the Engineer and new work shall not be opened up until such defects have been remedied.

The Contractor shall not open up more than two miles at one operation and at no time shall there be more than four miles under process of oiling construction.

All bridges, sign posts, guard fence and any other roadside structures shall be adequately protected from being discolored by splashing oil. Compensation for furnishing, erecting and removing such protection shall be included in the unit price bid for the application of the oil.

No oil shall be spread as a tack coat or seal coat except under the direction of the Engineer.

No portion of the oil mat shall be spread or allowed to remain on the roadway until the entire mass is thoroughly mixed except for that small portion which the Engineer may allow to be dropped for a mixing floor.

23.4 Organization and Equipment. Each crew or each outfit engaged in the work to be done under this contract shall be under the continuous supervision of a competent superintendent ,thoroughly experienced in the class of work involved.

All graders, drags and oil distributors shall be manned by experienced operators.

All wheeled equipment, except scarifiers, used on this work shall be equipped with rubber tired wheels and all equipment shall be kept in good condition and repair at all times.

A unit of equipment shall consist of the following:

1 Pressure oil distributor.

1 Heating unit.

2 Spring tooth harrows.

1 Scarifying unit.

4 Complete mixing units.

The list of equipment given above indicates only the minimum requirements. In no case will any work be started unless the Contractor has on hand at least the number of units above outlined. If any additional equipment is needed for the satisfactory fulfillment of the conditions of the specifications or to insure completion of the work within the specified time limit, such additional equipment shall be furnished.

Graders must be kept in good condition and any machines having blades which cannot be held in a rigid position or that "chatter" will not be allowed on the work. The Engineer shall be the sole judge of the suitability of the equipment.

The oiling unit shall be equipped with pressure pump, pressure gauge, thermometer and tackometer to assure at all times a uniform spread of oil. Distributors with poor valves will not be allowed to work.

23.5 Rolling. As a part of the equipment for the construction of the project, the Contractor shall provide and maintain one or more rollers upon the job. The roller or rollers shall be self-propelled tandem type weighing not less than six (6) tons or a self-propelled three-wheel type weighing not less than ten (10) tons. As soon as the treated material has been finally spread and smoothed to the satisfaction of the Engineer, it shall be rolled. Rolling shall commence at the sides and progress towards the center, overlapping at each succeeding passage. At least two complete rollings shall be required.

The rolling shall not commence until the final blading or dragging shall have produced as nearly as possible a perfectly smooth and even surface, true to grade and cross-section. The Engineer shall be the sole judge as to when this degree of smoothness has been attained. If the road is under traffic, the surface shall be constantly maintained by blading or dragging until the rolling is completed. This final blading or dragging shall be done with a twelve foot blade grader having a wheel base of not less than sixteen feet and weighing not less than 5,600 pounds or with a wheel type multiple blade maintainer having a wheel base of not less than fifteen feet and weighing not less than 4,000 pounds.

23.6 Seal Coat. After the surface has been opened to traffic for a period of three weeks or more, should the Engineer consider it necessary to seal the surface, a seal coat consisting of the specified type and grade of bituminous material shall be applied. Before applying the seal coat the surface shall be swept free and clean so that no vegetable matter, paper, dust, or other obstructions might prevent a complete coverage or bond. The bituminous material shall be heated to a temperature within the limits specified in Article 23.2 (b) and shall then be spread at the rate of approximately one-eighth of a gallon per square yard of surface covered by means of a pressure distributor of approved type.

Traffic shall be routed over detours while the seal coat is being applied or the seal coat shall be placed one-half width of the road at a time and the other half of the roadway kept clear and open to traffic.

The state reserves the right to omit the seal coat if in the opinion of the Engineer it is not required.

23.7 Progress. No work shall be started prior to May 1st nor shall it be continued later than September 15th except on written permission of the Engineer.

After the work is started the progress shall be such as to insure completion within the time limit. At all time the ratio of the mileage of work to be completed to the total mileage shall be equal or less than the ratio of the number of working days remaining to the total number of working days computed from the date of actual starting of the work to the contract date of completion.

In case the Contractor has been awarded more than one state oiling contract his total mileage and total time will be considered, in computing his ratio of progress.

The failure of a Contractor to show satisfactory progress as outlined above and his failure to promptly provide sufficient additional equipment on request of the Engineer to insure satisfactory progress will be sufficient cause for cancellation of the contract or for the state to place on the job, at the Contractor's expense, sufficient equipment to insure satisfactory completion.

The point or points where the Contractor shall start work and program of procedure shall be outlined by the Engineer.

No work will be prosecuted except in daylight hours.

23.8 Protection of Traffic. In addition to safety measures provided for in Article 7.8, the Contractor will be required to maintain two watchmen, one at each end of the work, at all times it is in progress in order to warn and direct traffic. Work will be considered in progress at all times Contractor's equipment is in the roadway, regardless as to whether it is in motion or not, or when material has not been stacked in a safe manner, satisfactory to the Engineer. All material shall be left in a uniform stack, placed where the Engineer may direct, at night or at other times when work is not in progress, in order to leave the roadway in the best possible condition for the safe use of the public. If rain occurs, and material is stacked in accordance with the provisions of the contract, the Contractor shall not allow puddles of water to remain on the roadway but shall promptly drain them to the ditches.

23.9 Methods of Measurement. (a) The asphaltic road oil and cut-back asphalt shall be measured by the U. S. Gallon measured at a temperature of 60°F. or corrected to this basis as prescribed in the standards of the American Society for Testing Materials, Serial Designation D 206-34. The quantity in each car shall be determined from the producer's invoice, checked by the Engineer in the field.

(b) Application of oil shall be measured by the U. S. gallon, the measurement being made as herein provided in paragraph (a).

(c) Processing, for all oil treated surfacing material complete in place and accepted by the Engineer, shall be measured by the mile, measured along the centerline of the roadway, or by the square yard, as called for in the proposal.

(d) Seal Coat Oiling, if required, shall be measured by the U. S. gallon of bituminous material actually applied, the measurement being made as herein provided in paragraph (a).

23.10 Basis of Payment. Payment for road mix oil treatment shall be made as follows:

(a) Application of oil shall be paid for at the contract unit bid price per gallon, which price shall include all demurrage, storage, handling and other charges incurred after receipt of the oil at the railroad destination point, all materials (including the road oil), tools, equipment, and labor, and the performance of all work necessary or incidental to the unloading, heating, hauling and spreading of the oil.

(b) Processing shall be paid for at the contract unit price bid per mile or per square yard, as the case may be, which price shall include all materials, equipment, tools, labor and work required under these specifications and for which payment is not otherwise made, and including the preparation of the existing roadway, mixing the oil and road metal, rolling, and completing the oil treatment as herein described.

(c) Seal Coat Oiling, if required, shall be paid for at the unit price bid per gallon for this item, which price shall be full compensation for the necessary sweeping of the surface and for furnishing, heating, hauling, and spreading the bituminous material.

STATE OF MONTANA

State Highway Commission

Standard Specifications
for
Highway Construction

DIVISION 2—CONSTRUCTION DETAILS
PART 3—STRUCTURES

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HELENA, MONTANA

SECTION 24.

REMOVAL OF EXISTING TIMBER, STEEL AND CONCRETE STRUCTURES.

24.1 Description. This item shall consist of the removal and satisfactory disposal of all portions of existing structures, except such portions as may be required or permitted to be left in place by these specifications, the plans, or the special provisions, and also the maintenance of traffic and all other operations specified in this section.

24.2 Removal of Superstructures. Steel superstructures and wooden bridges shall be dismantled and removed in such manner as to avoid damage to any member thereof. Concrete and masonry superstructures shall be removed and disposed of as provided in paragraph 24.4 unless otherwise specified.

Steel and/or timber trusses of superstructures shall be removed in a condition suitable for re-erection. All members of the trusses shall be match-marked with paint before they are dismantled. All pins, nuts, loose plates, etc., shall be similarly marked to indicate their proper location; all pins, pin holes, and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be wired to adjacent members or packed in boxes.

24.3 Removal of Substructures. Unless otherwise specified or ordered by the Engineer, all portions of the substructures of existing structures above the bed of the stream, finished ground surface, or ground surface as it existed before the work was started, and all portions below the bed of the stream or ground surface which interfere in any way with the new construction, shall be removed. Blasting or other operations which might endanger the new work shall be completed prior to the construction of any part of the new structure.

Where piles compose the substructure, or a part thereof, the Contractor shall cut off the piles one foot below the finished ground surface or pull them, as he prefers. However, if they interfere with the new construction, he shall remove them completely.

24.4 Disposal of Materials Removed. (a) *Structural Steel.* Structural steel members removed from the old structures shall, unless otherwise specified or directed, be stored in a neat and presentable manner in locations designated by the Engineer, within the right of way and adjacent to the site of the work. Members of structures which are to be re-erected and all steel beams shall be stored above the ground surface on skids or otherwise protected as directed by the Engineer.

(b) *Concrete and Masonry.* Concrete and masonry which is removed from old structures, shall, as far as practicable, be placed in back fills or approach embankments or shall be used to riprap the slopes of the embankments or the channel if specified on the plans. Any concrete or masonry which cannot be placed in back fills or embankments or used as riprap shall be disposed of as directed by the Engineer and in such manner as to prevent damage to property or the creation of unsightly conditions.

(c) *Timber and Other Materials.* All timber and other materials having salvage value shall be piled up in a neat and presentable manner in locations designated by the Engineer, within the right of way and adjacent to the site of the work.

(d) *Ownership of Materials Removed.* All materials having salvage value shall be disposed of as provided herein and shall be considered the property of the State. Permission to use any of these materials in the Contractor's operations shall be secured from the Engineer.

24.5 Maintenance of Traffic. If there are existing structures at or near the site of any of the new bridges to be constructed, the Contractor shall provide and maintain a suitable detour to accommodate ordinary traffic, and he shall also provide and maintain adequate barricades, signs and lights to safeguard the traveling public. The existing structures may be used in the detour. However, if modifications are required because any existing structure interferes with the construction of the new bridge, plans for such modifications shall be approved by the Engineer before changes are made.

Where there is no existing structure at the bridge site and the new construction makes it necessary for traffic to use the road, the Contractor shall provide and maintain a suitable detour to accommodate ordinary traffic, and he shall also provide and maintain adequate barricades, signs and lights to safeguard the traveling public.

24.6 Disposal of Temporary Structures, Cleaning Site, etc. Upon the completion of the new structures, with the necessary backfilling and roadway embankments, the Contractor shall remove and dispose of any temporary structure he may have installed in connection with the maintenance of traffic,

to the satisfaction of the Engineer; and, furthermore, he shall leave the adjacent premises in such condition as to present neat and acceptable appearances.

24.7 Basis of Payment. If the contract contains a separate item and price for "Removal of Existing Structures," such price shall be payment in full for the removal and disposal of the existing structures, maintenance of traffic, and all other operations specified in this section.

If the contract does not contain a separate item and price for "Removal of Existing Structures," payment in full for the work specified in this section shall be considered as included in the contract unit prices for the various items of the contract.

The stipulations of Article 4.5 shall not apply to the construction and maintenance of detours at bridge sites, but the stipulations of this section (24) shall govern all such work.

SECTION 25.

REMOVAL OF PIPE CULVERTS.

25.1 Description. This item shall consist of the removal and satisfactory disposal of old pipe and wood box culverts and culvert headwalls which are not to be used in place as a part of the new construction.

25.2 Construction Methods. The old pipe culverts and headwalls shall be removed by the Contractor and the material shall be piled adjacent to the road as directed by the Engineer. Care shall be taken so as not to damage the material and the pipe shall remain the property of the State. While removing old culverts, the Contractor shall so conduct his operations as to interfere as little as possible with traffic, and any work necessary or incidental to detouring and maintaining traffic around any culvert which is being removed shall be done by the Contractor at his own expense.

25.3 Method of Measurement and Basis of Payment. The excavation work necessary for the removal of old culverts and headwalls shall be measured and paid for as "Structure Excavation" in accordance with the provisions of Article Nos. 12.4 and 12.5 of these specifications. All other work involved in removing the old culverts, including the removal of headwalls, shall not be paid for directly, but shall be considered as subsidiary work pertaining to the roadway and drainage excavation items.

SECTION 26.

CONCRETE.

26.1 Description. This item shall consist of concrete masonry composed of approved Portland cement, fine aggregate, coarse aggregate and water, prepared and constructed in accordance with these specifications where, and of the form, dimensions and class shown on the plans or directed in writing by the Engineer.

26.2 Classification. Concrete will be classified as Class A, Class B, Class D or Class S. Each class of concrete shall be used in that part of the structure in which it is called for on the plans, or where directed. The following requirements shall govern unless otherwise shown on the plans:

Class A concrete shall be used (except where Class D is required) for all superstructures and all arch rings, and for all parts of substructures having a least dimension less than one foot and for all reinforced concrete except footings.

Class B concrete shall be used (except as provided above and except where Class S is required) for substructures, for footings and for unreinforced concrete.

Class D concrete shall be used for railings, posts, slabs, beams, girders and curbs.

Class S concrete shall be used for all concrete deposited under water.

26.3 Composition of Concrete and Proportioning. The Contractor shall put into each batch the designated number of bags of cement and the amount of water, and weigh into each batch the respective weights of fine and coarse aggregates designated by the Engineer for the particular job materials and class of concrete being used, provided that the largest structure in the project shall have a total of 200 or more cubic yards of concrete of all classes.

The Engineer, subject to the requirements of the "Master Proportion Table," shall designate the respective amounts of the job materials to be used in the batch, and shall fix the amount of water. The sum of the weights of fine and coarse aggregate designated for each class of concrete shall equal the "FIXED" weights shown in the "Total Aggregate" column for the respective types of material. Within the ranges of the table, the Engineer shall designate the weight of fine aggregate which, using the materials furnished, will produce a workable mix of the consistency hereinafter specified with the least amount of water. In the event that volumetric measurement is to be used the Engineer shall determine the weights per cubic foot of the aggregates under job conditions and convert the designated batch weights into cubic feet. If, during construction, the concrete at any time is found unsatisfactory, the Contractor shall readjust his batch subject to requirements of the Master Table tabulated below, as ordered by the Engineer, until the consistency of the mix actually being used on the job complies with the consistency requirements.

MASTER PROPORTION TABLE.

Class	When Coarse Aggregate Used Is:	Weight of Fine Aggregate Per Bag of Cement		Weight of Total Aggregate Per Bag of Cement —FIXED—
		Minimum	Maximum	
		Pounds	Pounds	Pounds
A	Gravel	180	220	
	Stone	216	264	580
B	Gravel	216	264	
	Stone	270	330	750
D	Gravel	135	165	
	Stone	170	210	470
S	Gravel	120	140	
	Stone	155	185	430

For each class of concrete the pounds of coarse aggregate per bag of cement shall be the difference between the "FIXED" pounds, shown in the "Total Aggregate" column above for the type of coarse aggregate to be used, and the pounds of fine aggregate as designated by the Engineer.

The above tabulation is based on the apparent specific gravity of 2.65 for both fine and coarse aggregate. Corrections shall be made for variations therefrom in the job materials of more than .05 up or down, so as to maintain the same absolute volume of aggregates per unit volume of concrete. The weights are weights of dry aggregates.

The determination of proportions, as stipulated above, will be based on representative samples of the materials to be used. No change in the source ,character or grading of the materials shall be made without due notice to the Engineer, and no work shall proceed using such changed or new materials, or using any materials not possessing all the qualities and properties upon which the designated mix and proportions have been based, until the Engineer has duly determined and designated an appropriate mix based on the new or altered material. All materials shall meet the requirements for "Materials" as hereinafter cited.

In all cases references to coarse aggregates shall be taken to mean all the aggregates in the mix which under test would be retained on the one-quarter-inch screen, and fine aggregate shall be taken to mean all aggregates in the mix which would pass the one-quarter-inch screen. In the event that either or both aggregates contain more than 10 per cent of material which under the above definition would be classed as the other aggregate, adjustment in the batch weight shall be made.

26.4 Materials. (a) *Portland Cement.* The cement used for this work shall be a standard brand of Portland cement and shall conform to the requirements and tests provided in the Standard Specifications of the American Society for Testing Materials, serial designation C 9-30, with subsequent amendments and additions thereto adopted by the Society. Only one brand shall be used in any one contract, except by specific written permission of the Engineer.

The Contractor shall provide suitable means for storing and protecting the cement against dampness. Different brands or grades of cement shall be stored separately and shall not be mixed nor used alternately.

Bags of cement which for any reason have become partially set, or contain lumps of caked cement, shall be rejected. Use of cement salvaged from discarded or used bags will not be permitted.

(b) *Water.* All water used in concrete shall be subject to the approval of the Engineer and shall be reasonably clear and free from oil, acid or alkali and vegetable substances, and shall not be brackish or salty. Water of doubtful quality shall be tested in briquettes as prescribed in Tentative Method T-26 of the American Association of State Highway Officials, "Method of Test for Quality of Water to Be Used in Concrete," with subsequent amendments by the Association, and the strength of such briquettes shall be equal to similar briquettes made of water of known satisfactory quality.

(c) *Fine Aggregate.* The fine aggregate for concrete shall consist of sand or a combination of sand and stone screenings conforming to the following requirements:

All sand shall consist of clean, hard, durable, uncoated grains, free from lumps, soft or flaky particles, organic matter, loam or other deleterious substances. Sand shall be free from salt and alkali.

All stone screenings shall consist of clean, dustless screenings resulting from the crushing of tough, durable rock having a per cent of wear of not more than 5 as determined by Tentative Method T-3 of the American Association of State Highway Officials, "Method of Test for Abrasion of Broken Stone and Broken Slag," with subsequent amendments by the Association. They shall be free from thin, elongated, or laminated pieces, disintegrated stone, vegetable or other deleterious matter. Screenings shall be free from salt and alkali.

Fine aggregate shall be well graded from coarse to fine and, when tested by means of laboratory screens and sieves, shall meet the following requirements:

	Per cent
Passing ¼-inch screen	100
Passing a standard 20-mesh sieve	40-75
Passing a standard 50-mesh sieve	5-30
Passing a standard 100-mesh sieve, not more than	5
Weight removed by elutriation test, not more than	3

The fine aggregate shall be of such quality that mortar composed of 1 part Portland cement and 3 parts of fine aggregate, by weight, when made into briquettes and tested in accordance with methods described in the Tentative Method T-35 of the American Association of State Highway Officials, "Methods of Making Compression and Tension Tests of Fine Aggregate for Concrete," with subsequent amendments and additions thereto adopted by the Association, will show, at ages of 7 and of 28 days, not less than the following tensile strength ratios when compared with simultaneous tests of briquettes made at the same time from 1 to 3 mortar of the same consistency and composed of the same cement and standard Ottawa sand: Class A, D and S concrete, 100 per cent; class B concrete, 85 per cent. If the 7 day ratios are in excess of 115%, the fine aggregate may be accepted at the option of the laboratory, without further tests.

(d) *Coarse Aggregate.* The coarse aggregate for all classes of concrete shall consist of broken stone or gravel, all conforming to the respective requirements following:

Broken stone shall be obtained from clean, tough, durable rock having a per cent of wear of not more than 5, as determined by Tentative Method T-3 of the American Association of State Highway Officials, "Method of Test for Abrasion of Broken Stone and Broken Slag," with subsequent amendments by the Association. It shall be free from thin, elongated, or laminated pieces, soft or disintegrated stone, vegetable or other deleterious substances. Broken stone shall be free from salt and alkali.

Gravel shall consist of clean, hard, and uncoated pebbles of high resistance to abrasion. Gravel shall be free from salt and alkali.

Coarse aggregate shall be well graded from the maximum size to pieces one-quarter inch in diameter. The maximum size will generally be given on the plans, but if not given the following shall govern:

For class A concrete and class S concrete the aggregate shall have a maximum size not greater than will pass a screen having a circular opening one and one-half inches in diameter; for class B concrete the aggregate shall have a maximum size not greater than will pass a screen having circular openings three inches in diameter; for class D concrete the aggregate shall have a maximum size not greater than will pass a screen having circular openings one and one-half inches in diameter, except for girder spans and sections eight inches and less in thickness, for which one-inch shall be used, and for handrails and concrete pipes for which three-fourths inch shall be used.

When tested by means of laboratory screens, coarse aggregate shall meet the following requirements:

Percentages of coarse aggregate passing the various laboratory screens.

Maximum Size of aggregate	3-inch Screen	2½-inch Screen	2-inch Screen	1½-inch Screen	1¼-inch Screen	1-inch Screen	¾-inch Screen	½-inch Screen	Passing screen having circular openings ¾ in. in diameter, not more than
3	100			40-75					5
2½		100			40-75				5
2			100			40-75			5
1½				100			40-75		5
1¼					100			35-70	5
1						100		40-75	5
¾							100		5

Rubble one-man stone may be embedded in class B concrete when shown on the plans, or when the same is a plain mass concrete more than 2 feet in thickness, and permitted by the Engineer. These stones shall not be placed within 6 inches of any finished surface of the concrete and shall be placed at least 6 inches apart. The stone for this purpose shall consist of clean, sound, rubble stone, free from structural defects, foreign substances, and coatings of any character, shall be laid on their natural bed, and shall be washed and of a quality satisfactory to the Engineer.

(e) *Sampling Aggregates.* The fine and coarse aggregates shall be sampled in accordance with the method described in Tentative Method T-2 of the American Association of State Highway Officials, "Methods of Sampling Stone, Slag, Gravel, Sand, and Stone Block for Use as Highway Materials, Including Some Material Survey Methods," with subsequent amendments and additions thereto adopted by the Association.

(f) *Testing Concrete.* The concrete for testing purposes shall be made with the fine and coarse aggregate and cement proposed for use on the work, and the concrete shall be mixed to the same consistency as will be used in construction. The methods to be followed in making and testing specimens of concrete shall be those described in Tentative Method T-23 of the American Association of State Highway Officials, "Method of Making and Storing Compression Test Specimens of Concrete in the Field," with subsequent amendments and additions thereto adopted by the association. When so tested they shall give the following average crushing strengths:

	Class A	Class B	Class D	Class S
Strength, per square inch, 7 days	1,400	1,100	1,800	1,400
Strength, per square inch, 28 days	2,200	1,600	2,800	2,200

Fine and coarse aggregates conforming to the requirements of these specifications except for grading and mortar strength test may be used, with the approval of the Engineer, provided the concrete proportions are altered to give the average crushing strengths specified above. In no case, however, shall fine aggregates be used which contain more than 3 per cent, by weight, of material removable by the elutriation test. Only such proportions shall be used as will produce a workable mixture and a dense concrete. If the specimens fail to fulfill requirements for 7-day tests, the aggregate may be accepted if specimens will fulfill requirements for the 28-day tests.

(g) *Filler for Expansion Joints.* The joint filler shall be of the premoulded type and shall be a uniform product, composed of tar or asphalt incorporated with a fibrous substance or other inert material. The joint filler shall be of suitable quality and composition so that during hot weather it will not be deformed by handling, and so that during cold weather it will not become brittle and shatter. The joint filler shall meet the following requirements when tested in accordance with the method described in Tentative Method T-42 of the American Association of State Highway Officials, "Methods of Sampling and Testing Premoulded Joint Fillers," with subsequent amendments by the Association:

Absorption—Not more than 5 per cent by weight,
Distortion—Not more than one inch,
Brittleness—The specimen shall not crack or shatter under the test.

26.5 Method of Construction. (a) *Falsework.* Falsework for supporting concrete work shall be built on foundations of sufficient strength to carry the loads without appreciable deformation. Falsework which can not be founded on solid footings must be supported by ample falsework piling. Falsework shall be designed to carry the full loads coming upon it. All spans shall be given a temporary camber of 1/40 inch per foot of clear span to allow for shrinkage and settlement. Bridges shall have a permanent camber only when shown on the plans. If appreciable settlement occurs in the falsework, the work shall be stopped, any masonry affected shall be removed and the falsework rebuilt. In general, double wedges or other suitable means shall be provided for constructing and maintaining falsework and forms to correct lines.

If requested by the Engineer, detail drawings of the falsework shall be submitted to the Engineer for approval, but such approval shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the improvement. Arch centering shall be so constructed as to permit of its being gradually and uniformly lowered or released after pouring the arch ribs or rings.

(b) *Forms.* Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Forms for exposed surfaces shall be made of sized and dressed tongue and groove or shiplap lumber or metal in which all bolt and rivet holes are countersunk so that in either case a plane smooth surface of the desired contour is obtained. Undressed lumber may be used for backing or for surfaces which will not be exposed in the finished structure. All lumber shall be free from knot holes, loose knots, cracks ,splits, warps, or other defects affecting the strength or appearance of the finished structure. Form lumber shall be free from bulge or warp, and shall be thoroughly cleaned if used a second time.

In designing forms and centering, the concrete shall be treated as a liquid weighing 150 pounds per cubic foot for vertical loads, and not less than 85 pounds per cubic foot for horizontal pressure. The unsupported length of wooden columns and compression members shall not exceed 30 times the diameter or least side.

The forms shall be so designed that portions where finishing is required may be removed without disturbing portions of forms which are to be removed later, and, as far as practicable, so that form marks will conform to the general lines of the structure. Column form marks shall be vertical and symmetrically placed.

When possible forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit of free access to the forms for the purpose of inspecting, working and spading the concrete.

The forms shall be built to line and braced in a substantial and unyielding manner. Wires for tying forms shall not extend through faces of concrete that will be exposed in the finished work. In general, forms shall be tied together with bolts that can be removed. The forms shall be mortar tight and if necessary to close cracks due to shrinkage shall be thoroughly soaked with water. Forms for reentrant angles shall be chamfered and for edges shall be filleted. The interior surfaces of forms shall be adequately oiled, greased, or soaped to insure nonadhesion of mortar. Forms shall be inspected by the Contractor immediately prior to placing concrete. Dimensions affecting construction of subsequent portions of the work shall be carefully checked and any bulging or warping shall be remedied and all dirt, sawdust, shavings or other debris within the forms shall be removed. Special attention shall be paid to ties and bracing, and where forms appear to be insufficiently braced, or unsatisfactorily built, either before or during construction, the Engineer shall order the work stopped until the defects have been corrected to his satisfaction. Forms shall be so constructed that the finished concrete shall be of the form and dimensions shown on the plans and true to line and grade. Clean-out ports shall be provided at the top surface of concrete where a stoppage of placing occurs.

(c) *Handling, Measuring and Batching Materials.* Concrete of the classes indicated shall be made up of acceptable material batched in the proportions set by the Engineer for the specific materials. Corrections necessitated by variations from day to day in the moisture content of the raw materials or for other similar reasons shall be made as directed by the Engineer, based upon laboratory determinations.

The coarse and fine aggregate must be handled and measured separately. No batch shall be run requiring fractional bags of cement.

Cement shall be measured by the bag as packed by the manufacturer.

Water shall be measured either by volume or by weight. The allowable error in accuracy of water measuring equipment on the mixer shall not be more than two per cent. The equipment should preferably include an auxiliary tank from which the measuring tank shall be filled, and in any case shall be so arranged that the accuracy of measurement will not be affected by variations in pressure in the water supply line.

(d) *Equipment for Weighing Aggregates.* All equipment used for the weighing of fine and coarse aggregates shall meet with the approval of the Engineer. The equipment used shall comply with the following requirements:

(1) Types of Equipment Permitted. The following general types of equipment will be permitted:

a. Portable Platform Scales—Type A. This type shall consist of a portable platform scale having a container fastened securely to the platform.

b. Portable Platform Scales—Type B. This type shall consist of a portable platform scale having a platform sufficiently large to permit the weighing of loaded wheelbarrows or carts.

c. Suspended Hopper—Type C. This type shall consist of a weighing container or hopper completely suspended from the scales equipment.

d. Other Types. Other types of weighing equipment shall be used only with the written approval of the Engineer.

(2) General Requirements. The following general requirements shall apply to all types of weighing equipment:

a. Weighing Container. The weighing container shall be of suitable size and shape and shall be tight enough to hold the aggregate for which it is to be used without leakage.

b. Container. The weighing container and its appurtenances shall be designed and constructed so as to eliminate the retention of varying tare materials on any of its parts, and shall be capable of being discharged fully and quickly without shaking and jarring the scales.

c. Types of Scales. The scales, that is, the balance or weighing mechanism, shall be of the beam or springless dial type and shall be the product of an established manufacturer. They shall be suited for supporting weighing containers, and shall be of simple rugged design with a minimum number of adjustments consistent with the accuracy required.

d. Scale Levers. The scale levers shall be of such design, construction, and materials as to permit frequent handling without damage incident to moving the equipment from one location to another.

e. Pivots. Pivots shall be of steel properly hardened and tempered to obtain minimum wear under repeated weighing. They shall be accurately set in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and prevent them from working loose from the vibration incident to the service for which the scales are intended.

f. Connections. All connections shall be of such construction as to prevent the displacement of scale parts, without restricting the necessary movement of working parts. All adjustable or bolted connections or hangers shall be provided with suitable locking devices to prevent nuts working loose with resulting displacement of parts.

g. Poise Stops. Full capacity weigh beams shall be fitted with suitable poise stops for locating the poise to indicate predetermined weights.

h. Weighing Position of Beam. The weighing position of the weigh beam shall be horizontal. The trig loop shall allow movement of the weigh beam above and below the horizontal position, and the free end of the weigh beam shall be equipped with a suitable device for indicating clearly and accurately the horizontal position of the weigh beam.

i. Indicators. Scales of the suspended hopper type shall be equipped with a device for indicating to the scale operator that the required load in the weighing container is being approached, such as a telltale dial. Such device shall indicate at least the last fifty (50) pounds of load.

j. Poises. Poises shall be so constructed that they cannot be easily removed from the beam and shall be equipped with a suitable device for holding them firmly in position. Poise and weigh beams shall be of such material as will not corrode and contact surfaces shall not wear excessively.

k. Graduated Dials. Graduated dials shall have suitable markers, located inside the glass cover and closely in front of the dial, which may be set to indicate the position of the dial indicator for predetermined loads in the weighing container. Proper provision shall be made to prevent dirt from collecting in and around the dial mechanism. Suitable provision shall be made for obtaining and maintaining proper alignment between the dial and the part of the scale which transmits load to the dial. The dial face shall be of material not affected by moisture.

l. Minimum Graduation. The value of the minimum graduation on any scale shall not be greater than two (2) pounds.

m. Telltale Dials. The over-travel of telltale dials shall be at least one-third (1/3) of the loading travel. They shall give positive indication of overload on the scales. The dial faces shall be made of a material not affected by moisture. Where telltale dials are used to indicate the last increment of load, the minimum graduation shall not be greater than two (2) pounds.

n. Accuracy. Scales shall be so designed and built that they may be maintained within a maximum tolerance of one (1) per cent of the net load being weighed.

o. Clearance. Clearance shall be provided between the scale parts and the weighing container to prevent displacement of or friction between the scales parts due to vibration or any other cause.

p. Test Weights. Each scales installation shall be provided with standard fifty (50) pound test weights, made of high quality cast iron, cast and finished in such manner that no foreign material will adhere to the surface, and sealed in the manner prescribed by the United States Bureau of Standards. The minimum number of test weights required shall be of a weight equivalent to ten (10) per cent of the net load capacity of the scales to the nearest greater fifty (50) pounds, but in no case less than two (2) test weights.

q. Number of Scales Required. Unless the scale is equipped with a multiple weigh beam which permits the weighing of more than one kind of material on the same scale without changing the settings on the weigh beams, separate scale units shall be furnished for each kind of material to be weighed.

r. Working Parts. All working parts of scales, particularly knife edges, shall be protected so as to prevent any material except wind borne material from falling upon or against them. All working parts shall be readily accessible for inspection and cleaning.

s. Foundation and Leveling. Scales shall be mounted upon a firm foundation and shall be kept level during use.

t. Varying Tare Equipment. Weighing containers, not an assembled part of the weighing equipment, shall be brought to uniform tare weight by rigidly attaching to the lighter containers such weight as will bring each to the weight of the heaviest container being used on any operation.

(3) Detailed Requirements for Portable Platform Scales—Type A. The capacity of this type of scale shall be not less than 500 pounds. The weighing capacity may be obtained by means of a weigh beam and loose weights. The weigh beam shall be graduated either 50 x ¼ lbs., or 100 x ½ lbs.

When this type of scale is used, the Contractor shall provide a container of approximately the same size as the platform for weighing the aggregate, or, he may provide an elevated hopper, the base of which is approximately the size of the platform, from which the aggregate may be discharged.

If a hopper is provided, it shall be of such design that the aggregates will be completely and quickly discharged, and so designed that the position of the aggregates while being weighed will not affect the accuracy of the weights.

The Contractor will not be permitted to increase the size of the original platform by constructing another platform on top of the original. When this type of scale is used, a double weigh beam is recommended, so that the tare weight of the container or hopper may be set on the weigh beam separately from the batch weight. Separate scales for fine and coarse aggregate will be required.

(4) Detailed Requirements for Portable Platform Scales—Type B. The capacity of this type of scale shall be not less than 1,000 pounds and the weighing capacity may be obtained by means of a weigh beam and loose weights. The weigh beam may be graduated either 100 x ½ lbs., or 100 x 1 lb. The scale shall be preferably equipped with a double weigh beam, so that the tare weight of the wheelbarrow or other vehicle for transporting the aggregates may be set off on the weigh beam separately from the batch weights. When the scale is equipped with a single beam, or a single beam and a tare beam, separate scales shall be provided for fine and coarse aggregates.

When this type of equipment is designed to weigh more than one kind of material on the same scale, it shall be equipped with separate charging beams and a tare beam. Each charging beam shall be equipped with a release lever to throw the beam in and out of service. This type of scale may also be equipped with a telltale dial meeting with the requirements of these specifications.

(5) Detailed Requirements of Suspended Hopper—Type C. The detailed requirements for this type of scale shall comply with the provisions of Paragraph (2) above. Suitable provisions shall be made for leveling the scales equipment.

(e) *Consistency.* The quantity of mixing water used shall not be changed without the consent of the Engineer. The consistency of the various classes of concrete, when determined in accordance with the A.S.T.M. Tentative Method of Test for Consistency, D 138-26T, shall be

Class A	2 —4 inches slump
Class B	1½—3 inches slump
Class D	4 —6 inches slump
Class S	6 —8 inches slump

The above ranges represent the extreme limits of allowable slump. In all cases the amount of water used shall be the minimum necessary to secure the required workability of the concrete, within the ranges of slump specified.

(f) *Mixing.* The concrete shall be mixed only in such quantities as are required for immediate use. No retempering of the concrete will be allowed. Aggregates or bags of cement containing lumps or crusts of hardened material shall not be used.

Concrete shall be thoroughly mixed in a batch mixer of approved type and capacity for a period of not less than one and one-half minutes after all materials, including water, are in the drum.

During such period, the drum shall be operated at drum speeds specified by the mixer manufacturer and shown on his nameplate on the machine. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein and the mixer preferably shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced.

The mixer shall be equipped with an approved timing device which will automatically lock the discharging device so as to prevent the emptying of the mixer until the materials have been mixed the minimum specified time. No mixer shall be operated above its rated capacity and no mixer shall be used which has a rated capacity of less than a one-bag batch.

The first batch of concrete material placed in the mixer shall contain an additional quantity of sand, cement and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

Hand mixing will not be permitted, except in case of emergency and under written permission from the Engineer. When permitted, it shall be done only on water-tight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is procured. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and re-turned at least six times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed ½ cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

(g) *Placing Concrete.* Concrete shall be placed in the forms immediately after mixing and in no case shall concrete be used which does not reach final position in the forms within 30 minutes after water is first added to the mix. The method of placing shall be such as to avoid segregation of the aggregates or displacement of reinforcement.

Use of long chutes for conveying concrete from mixing plant to forms will not be permitted. Troughs, pipes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete are not separated. Where steep slopes are required the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. When pipes are used they shall be kept full of concrete and have their lower ends kept buried in fresh concrete in the same manner that a tremie is used. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms.

Special care shall be taken to fill each part of the forms by depositing concrete directly as near final position as possible, to work the coarser aggregates back from the face and to force the concrete under and around the reinforcement bars without displacing them. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

Concrete shall be compacted by continuous working with a suitable tool in a manner acceptable to the Engineer. Slab and girder work, arch ribs and all thin section work shall be thoroughly worked with a steel splicing rod. All faces shall be well spaded and the mortar flushed to the surface of the forms by continuous working with a concrete spading implement acceptable to the Engineer.

The placing of concrete shall be done in such manner that the steel reinforcing is not coated with cement before its final embedment. In depositing concrete around steel shapes and closely spaced reinforcing bars the concrete shall be deposited on one side of the steel and worked until it flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel. In all cases where, on acount of the obstructions produced by reinforcement metal, shape of forms, or any other condition, difficulty is encountered in puddling the concrete adjacent to the

forms, the mortar content of the mix shall be brought into proper contact with interior surfaces by vibrating the forms.

The vibrations shall be produced by striking the outside surfaces of the forms with wooden mallets or by short, rapid vibrations transmitted to the forms by a light jack hammer or vibrator having a spud extending through the slab concrete and making contact with the form. The vibrator shall be used at intervals of about 2 feet in each direction and for a sufficient time to guarantee the compacting of the entire mass of concrete. The vibrator shall be similarly used on the outside of the forms for hand rails, pylons and adjacent to projections and recesses in pier and retaining walls to aid in compacting concrete and thoroughly filling the form.

Concrete shall be placed in each section of the work in a continuous operation working day and night, if necessary, to avoid stoppage planes. It shall be deposited in horizontal layers, placing thin layers at first that can be thoroughly worked into intimate contact with the concrete beneath. After a depth of 6 inches has been built up in this manner the thickness of the layers may be increased to a maximum of 12 inches. The depth of layers used shall be such that the succeeding layer will be placed before the previous layer has attained initial set. Each layer shall be compacted in a manner that will break up and obliterate any tendency to form a place of separation between the layers. If it is necessary, by reason of an emergency, to stop placing concrete before any section is completed, bulkheads shall be placed as the Engineer may direct. Any place where the placing of concrete is discontinued for a sufficient time to allow the concrete to take initial set shall be deemed a construction joint and treated as hereinafter described under "Forming Joints."

Horizontal layers so located as to produce a construction joint at a location wherein a "feather edge" might be produced in the succeeding layer, shall be formed by inset work so that the succeeding layer will end in a body of concrete having a thickness of not less than 6 inches.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 18 inches below the top of any face, unles the details of the work provide for a coping having a thickness of less than 18 inches, in which case, at the option of the Engineer the construction joint may be made at the under side of the coping.

After the concrete in finished surfaces has begun to set, it shall not be walked upon or otherwise disturbed in less than 48 hours.

The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such locations as will be hidden from view to the greatest possible extent. The method and sequence of placing concrete for the various types of concrete bridge construction shall be as specified below for the particular type of construction involved.

Placing Concrete in Reinforced Concrete Slab and Girder Bridges. Concrete preferably shall be deposited by beginning at the center of the span and working from the center towards the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers.

Concrete in slab spans shall be placed in one continuous operation for each span.

Placing Concrete in Beams. Each beam, between the limits shown on the plans or directed by the Engineer, shall be cast in one continuous operation. The top of the concrete shall be kept level and it shall be placed in layers, the thickness of which shall be proportioned to the rate of delivery of the concrete to the forms so that there will be no planes of initial set in any part of the unit. All key-ways, seats for secondary beams, dowels and bars that connect the beams with other units of the work shall be in place before the placing of concrete is commenced.

Concrete in T-beam or deck girder spans shall be placed either in one continuous operation or in two separate operations, each of which shall be continuous; first, to the top of the girder stems and, second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and shall be secured by means of suitable shear keys with or without dowels in top of girder stem. The size and location of these keys and dowels shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately 2 inches by 4 inches in cross section and having a length 4 inches less than the width of the girder stem. These key blocks shall be spaced along the girder stem as required but the spacing shall be not greater than one foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal.

Placing Concrete in Concrete Viaducts. Concrete in columns shall be placed in one continuous operation, unless otherwise directed. Columns shall be allowed to set at least 12 hours before the caps are placed.

No concrete shall be placed in the superstructure until column forms have been stripped sufficiently to determine character of concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least 21 days, unless otherwise permitted by the Engineer.

Placing Concrete in Concrete Arches. The concrete in arch rings shall be placed in such manner as to load the centering symmetrically. The centering shall be weighted if necessary to prevent distortion.

Arch rings shall be divided into sections of such size that when working simultaneously at points symmetrically located about the crown the sections can be cast in one continuous operation without permitting the formation of planes of initial set. The sections shall be bonded together by suitable keys or dowels. Adequate struts shall be provided to resist any unbalanced thrusts to piers in structures composed of more than one span. The size, arrangement, and sequence of placing concrete for sections of all arches shall be subject to the approval of the Engineer.

(h) *Depositing Concrete Under Water.* Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the Engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

All concrete deposited under water shall be mixed in the proportions designated for Class S concrete.

Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket or other approved methods and shall not be disturbed after being deposited. Special care shall be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water and all form work designed to retain concrete under water shall be water-tight. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used it shall consist of a tube having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the discharge and over the entire top of the work and to permit its being rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow is then stopped by lowering the tremie. The flow shall be continuous and in no case shall be interrupted until the work is completed.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than ½ cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

(i) *Forming Joints.* When the work of placing concrete is delayed until the concrete has taken initial set, the point of stopping shall be deemed a construction joint. The location of construction joints shall be planned in advance and shall be subject to approval by the Engineer. The placing of concrete shall be carried continuously from joint to joint. These joints shall be perpendicular to the principal lines of stress and in general be located at points of minimum shear.

At all horizontal construction joints and at other locations, when directed, a gage strip not less than 2 inches thick shall be placed inside the forms along all exposed faces to give the joint a straight line and eliminate wedge shaped particles of concrete that might chip off. In placing concrete up to construction joints the forms shall be "over filled" at least one inch and all excess material removed.

In joining fresh concrete to concrete that has already set, the forms shall be drawn tight against the face of the set concrete and all gage strips and key forms removed. The surface of the set concrete to be contacted shall then be cut over with suitable tools to remove all laitance, loose and foreign material. This surface shall then be washed and scrubbed with wire brooms, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the old surface shall be thoroughly coated with a very thin coating of neat cement mortar.

In order to bond successive courses, suitable keys shall be formed at the top of the upper layer of each day's work and at other levels where work is interrupted. These keys shall be formed by the insertion and subsequent removal of beveled wood strips which shall be thoroughly saturated with water prior to insertion. Rough stone or steel dowels may, at the discretion of the Engineer, be used in lieu of keys. All construction joints shall be keyed or doweled as shown on the plans or directed by the Engineer.

Sliding joints shall be true planes parallel to the direction of movement. Where sliding joints are to be provided at the ends of slabs, girders or beams, or between walls, etc., the surface of the sup-

porting concrete shall be given a smooth finish and covered with two layers of three-ply roofing felt to separate the concrete.

Unless otherwise shown on the plans, expansion joints shall be filled with an approved premolded bituminous filler. The thickness of the joints shall be ¼ inch where the length of the moving concrete is 20 feet or less, ½ inch for lengths 21 to 36 feet, and ¾ inch for lengths of 37 to 50 feet unless otherwise shown on the plans. The joint filler shall be cut to the same shape as the area to be covered but ¼ inch smaller along all surfaces that will be exposed in the finished work. It shall be firmly fixed against the surface of the concrete already in place in such manner that it will not be displaced when the concrete is deposited against it. Where necessary to use more than one piece to cover any surface, the joint between the separate pieces shall be covered with a layer of two-ply roofing felt, one side of which shall be covered with hot asphalt to insure proper retention. The ¼-inch space along the edges at exposed faces shall be filled with wooden strips of the same thickness as the joint material. These wooden strips shall be saturated with oil and have sufficient "draft" to make them readily removable after the concrete is placed. Immediately after the forms are removed the expansion joints shall be carefully inspected. Any concrete or mortar that has sealed across the joint shall be neatly cut and removed.

Special water-tight and flashed joints shall be constructed as shown on the plans.

(j) *Cold Weather Concreting.* During freezing weather the concrete shall be thoroughly protected until set and provision for heating the water, aggregates and the concrete shall be made. When concrete operations are carried on during freezing weather the aggregates shall be heated by either steam or dry heat to a temperature of not less than 70 degrees Fahrenheit and not more than 150 degrees Fahrenheit. The water shall be heated to a temperature between 130 degrees Fahrenheit and 150 degrees Fahrenheit. The temperature of the mixed concrete shall be not less than 65 degrees Fahrenheit and not more than 85 degrees Fahrenheit at the time of placing it in the forms. Neither salt nor chemical admixtures shall be added to the concrete to prevent freezing.

The Contractor shall assume all risk in connection with placing concrete in cold weather, and placing the concrete under freezing weather shall in no way relieve the Contractor of responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory it shall be removed and replaced at the Contractor's expense.

(k) *Curing Concrete.* Handrails, floors, and troweled surfaces shall be protected from the sun, and in drying weather the whole structure shall be kept wet for a period of 10 days. For concrete requiring finishing, the surface shall be kept moist until finishing is complete. Concrete floor slabs shall be covered with damp sand as soon as the concrete has taken hard set and then kept wet for 10 days. The covering material shall not be cleared from the surface of the floor for a period of 21 days, during which time no traffic shall pass over the structure. Other precautions to insure thorough curing of the concrete shall be taken by the Contractor as directed by the Engineer.

When directed by the Engineer, the Contractor shall furnish sufficient canvas and framework or other type of housing to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature not less than 65 degrees Fahrenheit for the first 10 days after the concrete is placed and 40 degrees Fahrenheit for the following 10 days.

The Contractor shall supply such heating apparatus as stoves, salamanders or steam equipment and the necessary fuel. When dry heat is used, means of maintaining atmospheric moisture shall be provided. The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material.

(l) *Removal of Forms and Falsework.* In order to facilitate finishing, forms on ornamental work, railings, parapets and exposed vertical surfaces shall be removed in not less than 12 or more than 48 hours, depending upon weather conditions. Forms under slabs, beams, girders and arches shall remain in place at least 21 days in warm weather and in cold weather at the discretion of the Engineer. Forms shall always be removed from columns before removing shoring from beneath beams and girders in order to determine the conditions of concrete in the columns.

No forms whatever shall be removed at any time without the consent of the Engineer. Such consent shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed with the forms and in no case shall any portion of the wood forms be left in the concrete. Lips of mortar and all irregularities caused by form joints shall be removed. The presence of excessive honeycomb areas may be considered sufficient cause for rejection of the structure, and upon written notice from the Engineer the Contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense.

As soon as the forms are removed, all projecting wire or other metal devices used for holding the forms in place and which pass through the body of the structure shall be cut back at least ¼

inch beneath the surface of the concrete and the holes or depressions thus made, and all other holes, depressions and small voids which show upon the removal of the forms, shall be repaired as follows: All coarse or broken material shall be chipped away until a dense uniform surface of concrete, exposing solid coarse aggregate, is obtained. Feather edges shall be cut away to form faces perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with a thick mortar mixed in the same proportion as that which was used in the body of the work and of the same temperature as the surface against which it is to be placed. The mortar shall be thoroughly tamped into place and the surface floated with a wood float before initial set takes place. The patch shall be kept wet for a period of five days, and when finished shall present a neat and workmanlike appearance.

For patching large or deep areas, coarse aggregate shall be added to the patching material and special precautions shall be taken to insure a dense, well bonded and properly cured patch, all as required by the Engineer.

Falsework shall not be removed at any time without the consent of the Engineer. Such consent shall not relieve the Contractor of responsibility for the safety of the work. Falsework shall remain in place after concreting is completed at least 21 days in warm weather and in cold weather at the discretion of the Engineer.

Falsework and centering for arches shall not be struck until the fill back of the abutments has been placed up to the spring line. Falsework for rigid frame structures shall not be removed until the fill has been placed back of the vertical legs.

(m) *Finishing Concrete.* All concrete surfaces exposed in the completed work shall comply with the requirements of the clause defining "Ordinary Finished Surface," except as otherwise provided or indicated on the plans.

The concrete bridge seats and tops of piers, walls and curbs shall be brought flush with the finished top surface and struck off with a straight edge and floated. The surfaces including bottom of overhung or cantilever portions of slabs, bottom and outside of exterior beams or girders, faces of abutments or walls above a point one foot below the ground or fill line, and all sides of curbs, handrails, columns, piers, arch ribs and struts shall be finished as provided herein for "Rubbed Finish."

(1) Ordinary Finish. An "Ordinary Finish" is defined as the surface left by the removal of the forms with all holes left by form ties filled and all defects repaired. The surface shall be true and even, free from stone pockets, depressions or projections beyond the surface. All surfaces which can not be repaired to the satisfaction of the Engineer shall be given a "Rubbed Finish."

(2) Concrete Floors. Concrete Floors shall be struck off with a templet immediately after pouring to provide the proper crown and shall be hand finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. The finished surface shall not show a variation of over ¼ inch in 10 feet using a 10-foot straightedge placed parallel to the center line of roadway and no variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The concrete in bridge seats and tops of walls shall be brought flush with the finished top surface, struck off with a straightedge and floated.

(3) Curbs and Sidewalk Surfaces. Exposed faces of curbs and sidewalks shall be finished to true surfaces having the lines and grades shown on the plans. Concrete shall be worked until the coarse aggregate is forced down into the body of the concrete and a layer of mortar ¼ inch thick is flushed to the top. The surface shall then be floated to a smooth but not slippery finish. The junction of the sidewalk with masonry parapets shall be finished with a fillet of ¾-inch radius. Walk surfaces shall be laid out in blocks with a grooving tool as shown on the plans or directed by the Engineer.

(4) Rubbed Finish. When forms can be removed while the concrete is still green the surface shall be wetted and rubbed with a wooden float until all irregularities and form marks are removed and the surface is covered with a lather composed of the cement and water. If permitted by the Engineer a thin grout composed of one part cement and one part fine sand may be used in the rubbing. This lather shall be allowed to set for at least 5 days. The surface shall then be smoothed by rubbing lightly with a fine carborundum stone. When the concrete has hardened before being rubbed a carborundum shall be used covering the surface in the following manner: A thin grout composed of one part cement and one part fine sand shall be spread over a small area of the surface and immediately rubbed with the stone until all form marks and irregularities are removed and the surface is covered with a lather, after which it shall be finished as described for green concrete. The surface shall be smooth and uniform in texture and appearance. Building up depressions will not be permitted. A cement wash or plaster coat shall not be used.

(n) *Drainage and Weep Holes.* Drainage and weep holes shall be constructed in the manner and where indicated on the plans or directed by the Engineer. Drains and weep holes in the face of the abutments shall be connected with the roadway drains wherever indicated on the plans. Ports or vents for equalizing hydrostatic pressure shall be placed below low water. Weep holes shall be placed at the elevations shown or directed.

Forms for weep holes through concrete may be clay pipe, concrete drain pipe, or wooden boxes. If wooden forms are used they shall be removed after the concrete is placed. Where weep holes pass through stone masonry the outlet through the masonry shall be rectangular in shape, from 2 to 3 inches in width and from 6 to 8 inches in height. Drain pipes embedded in concrete shall be standard light weight cast iron water pipe or wrought iron pipe. The pipe shall be rigidly held against displacement during the placing of the concrete.

No direct compensation will be allowed for drainage and weep holes and incidental work in connection therewith. The cost shall be considered as included in the unit prices bid for the various classes of concrete. No deduction will be made in the volume of concrete or masonry for the space occupied by drains and weep holes.

(o) *Pipes, Conduits and Ducts.* Pipes, conduits and ducts which are to be encased in the concrete, shall be installed by the Contractor as the concrete is being placed.

No direct compensation will be allowed for furnishing and installing all pipes and conduits shown on the plans. The cost of furnishing, installing and incidental work in connection therewith shall be considered as included in the unit prices bid for the various classes of concrete. No deduction will be made in the volume of concrete for the space occupied by pipes, conduits and ducts.

(p) *Defective Work.* Any defective work discovered shall be removed immediately and renewed. If the surface of the concrete is bulged, uneven, or shows honeycombing which in the opinion of the Engineer cannot be repaired satisfactorily, the entire section shall be removed and renewed. No compensation will be allowed for this work.

26.6 Method of Measurement. The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on plans or ordered in writing by the Engineer. No measurements or other allowances will be made for forms, falsework, cofferdams, pumping, bracing, etc.

26.7 Basis of Payment. The yardage, determined as provided above shall be paid for at the contract unit price bid per cubic yard for "Class A, Class B, Class D or Class S Concrete" as the case may be, which price and payment shall be full compensation for the concrete, for all materials, including expansion joint filler, water-stops, weep holes, pipes and conduits indicated on the plans, and for installation of all joints, weep holes, drains, pipes and conduits and for all timber bumpers, forms, falsework, placing and finishing, and for all labor, equipment, tools and incidentals necessary to complete the item, but shall not constitute payment for reinforcing steel, which will be paid for as a separate item.

SECTION 27.

REINFORCING STEEL.

27.1 Description. Under this item reinforcing steel, consisting of plain or deformed bars, or of steel mesh or expanded metal, shall be furnished and placed as called for on the plans or as directed. When deformed bars are specified, the form of the bars used must be approved by the Engineer and shall be such as to provide a net section at all points equivalent to that of a plain square or round bar of equal nominal size. The use of cold twisted bars will not be permitted. Steel mesh and expanded metal shall only be used when specified and shall be of the type shown on plans and approved by the Engineer.

27.2 Material. Reinforcing bars shall meet the requirements of the standard specifications for billet steel concrete reinforcement bars of intermediate grade, serial designation A 15-33, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

Where purchased from warehouse in small lots, reinforcements may, at the direction of the Engineer, be accepted subject to the bending test. Bend test specimens for plain and deformed bars shall

be taken from the finished bars, and shall be of the full thickness or diameter of bars as rolled, except that the specimens for deformed bars may be machined for a length of 9 inches, if deemed necessary by the manufacturer to obtain uniform cross-sections.

The test specimen shall bend cold around a pin without cracking on the outside of the bent portion, as follows:

BEND TEST REQUIREMENTS.

Thickness or Diameter of Bars	Type of Bar	
	Plain Bars	Deformed Bars
Under ¾ in.	180 degrees d = 2t	180 degrees d = 3t
¾ in. or over	90 degrees d = 2t	90 degrees d = 3t

d = the diameter of pin about which specimen is bent.
t = the thickness or diameter of the specimen.

Steel mesh or expanded metal shall be manufactured from material fulfilling the requirements of the standard specifications of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society, for billet steel concrete reinforcement bars, serial designation A 15-33.

27.3 Method of Construction. When placed, all reinforcement shall be free from dirt, oil, paint, grease, mill scale, loose or thick rust.

When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected. All reinforcement shall be placed in the exact position shown on the plans, and shall be so securely held in position by wiring to and blocking from the forms, and by wiring together at intersections that it will not be displaced during depositing and compacting of concrete. Precast concrete blocking should be used where applicable.

Placing and fastening of reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section.

When bar-bending diagrams are not shown on the contract plans, detail plans showing the bending of reinforcing bars shall be submitted to the Engineer for approval.

27.4 Splicing Reinforcement. Whenever it is necessary to splice reinforcement at points other than those shown on the plans, drawings showing the location of each splice shall be submitted and approved by the Engineer before the reinforcing steel is ordered. Splices shall be avoided at points of maximum stress; they shall, where possible, be staggered, and shall be designed to develop the strength of the steel without exceeding the allowable unit bond stress.

27.5 Determination of Weight. The weight of steel to be paid for shall be the theoretical weight of the steel as shown on the plans and accepted. The weights of standard sizes of reinforcing bars shall be computed in accordance with the following table:

¼ inch round	.167	lbs. per foot
⅜ " "	.376	" " "
½ " "	.668	" " "
½ inch square	.850	" " "
⅝ inch round	1.043	" " "
¾ " "	1.502	" " "
⅞ " "	2.044	" " "
1 " "	2.670	" " "
1 inch square	3.400	" " "
1⅛ " "	4.303	" " "
1¼ " "	5.313	" " "

If reinforcing bars, other than standard shapes, steel mesh or expanded metal is required, the unit weight will be shown on the plans.

27.6 Basis of Payment. The weight of steel thus determined shall be paid for at the contract unit price bid for reinforcing steel described on plans, which price shall be full compensation for furnishing the material, all equipment, tools, labor and incidentals necessary to complete the item. No allowance will be made for the clips, wire, separators, or other material used for fastening the reinforcing steel in place.

SECTION 28.

BOX CULVERTS AND RETAINING WALLS.

28.1 Description. All concrete and masonry culverts, end walls, and retaining walls shall be built as indicated on plans, conforming to line, grade and dimensions shown and in accordance with the specifications for concrete, masonry, and other items which are to constitute the complete structures.

28.2 Construction Methods. All foundations shall be prepared as hereinbefore specified under excavation for structures, and they shall be inspected and approved by the Engineer previous to placing any masonry or footing.

In general, the base slab or footings of box culverts will be placed and allowed to set before the remainder of the culvert is constructed. In this case suitable provision shall be made for bonding the sidewalls of the culvert base, preferably by means of raised longitudinal keys so constructed as to prevent, as far as possible, the percolation of water through the construction joint.

Before concrete is placed in the sidewalls the culvert footings shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified under "Forming Joints," Section 26.5 (i).

In the construction of box culverts four (4) feet or less in height, the sidewalls and top slab may be constructed as a monolith. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

In the construction of box culverts more than four (4) feet in height, the concrete in the walls shall be placed and allowed to set before the top slab is placed. In this case, appropriate keys shall be left in the sidewalls for anchoring the cover slab.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

Drains through all walls are to be placed as shown on plans or as directed by the Engineer in the field.

28.3 Method of Measurement. The quantities of the various items which constitute the completed and accepted structures will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

28.4 Basis of Payment. The measured quantities as provided above will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all material, all labor, equipment, tools, drains, and necessary incidentals. Such payment shall constitute full payment for the completed structures ready for use.

SECTION 29.

CONCRETE BRIDGES AND FLOOR SLABS.

29.1 Description. All concrete bridges and floor slabs shall be built as indicated on the plans, conforming to line, grade, and dimensions shown, and in accordance with the specifications for piling, concrete, reinforcing steel, and other items which constitute the completed structure.

29.2 Materials. All materials used shall be those prescribed for the several items which constitute the structure.

29.3 Method of Construction.(a) *Foundations.* All foundations shall be prepared as hereinbefore specified under excavation for structures, and they shall be inspected and approved by the Engineer previous to placing any concrete.

(b) *Drains.* Drains and waterstops shall be constructed as shown on plans or as directed by the Engineer.

(c) *Placing Concrete.* Concrete for slab and girder bridges preferably shall be deposited by beginning at the center of the span and working from the center toward the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers.

Concrete in girder haunches less than three (3) feet in height shall be placed at the same time as that in the girder stem and the column or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of three (3) feet or more, the abutment (or columns), the haunch and the girder shall be poured in three successive stages; first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

The operation of placing the concrete in any floor slab shall be continuous between expansion joints. In concrete floors supported by longitudinal joists, the joint shall be vertical, at right angles to the axis of the roadway, and over the center of the floorbeam. In concrete floors not supported by longitudinal joists, any necessary construction joints shall be located at the center of the slab span. In placing concrete around steel shapes it shall be placed only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which it shall be placed on both sides to completion.

The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case special shear anchorage shall be provided to insure monolithic action between girder and floor.

Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in two separate operations, each of which shall be continuous: first, to the top of the girder stems and, second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and shall be secured by means of suitable shear keys in the top of the girder stem. The size and location of these keys shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately 2"x4" in cross-section and having a length 4 inches less than the width of the girder stem. These key blocks placed transversely to center line of girders shall be placed along the girder stem as required but the spacing shall not be greater than one foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The columns shall be allowed to set at least 12 hours before the caps are placed.

Unless otherwise permitted by the Engineer, no concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. The load of superstructure shall not be allowed to come upon the columns until they have been in place at least 21 days, unless otherwise permitted by the Engineer.

The concrete in arch rings shall be placed in such a manner as to load the centering symmetrically.

Arch rings preferably shall be cast in transverse sections of such size that each section can be cast in a continuous operation. The arrangement of the sections and the sequence of placing shall be as approved by the Engineer and shall be such as to avoid the creation of initial stress in the reinforcement. The sections shall be bonded together by suitable keys or dowels. When permitted by the Engineer, arch rings may be cast in a single continuous operation.

(d) *Arch Centering.* Arch centering shall be constructed according to centering plans approved by the Engineer. Provision shall be made by means of suitable wedges, sand boxes or other device for the gradual lowering of centers at the time the arch is swung.

When directed, centering shall be placed upon approved jacks in order to take up and correct any slight settlement which may occur after the placing of masonry has begun.

No centering shall be removed from beneath any arch until the masonry has been in place at least twenty-eight (28) days. A longer period may be required at the discretion of the Engineer.

In general, centers shall be struck and the arch swung before the railing or coping is placed. This precaution is essential in order to avoid jamming of the expansion joints and variations in alignment. For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the striking of centers as may be necessary to avoid jamming of the expansion joints.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure. In arch structures of two or more spans, the sequence of striking centers shall be specified or approved by the Engineer.

29.4 Design. Concrete bridges will be designed in accordance with the specifications set forth in the "Design Specifications for Highway Structures."

29.5 Method of Measurement. The quantities of the various items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing by the Engineer.

29.6 Basis of Payment. The measured quatities as provided above, will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all materials, and for labor, equipment, tools, drains, waterstops and necessary incidentals. Such payment shall constitute full payment for the completed structure, ready for use, and no additional allowance will be made for cofferdam construction, falsework, form lumber, or other erection expenses.

SECTION 30.

STRUCTURAL STEEL.

30.1 Description. Structural steel complying with the dimensions and shapes prescribed on the plans shall be furnished and placed as shown thereon.

30.2 Materials. (a) *General.* The structural steel shall be of three kinds, namely structural rivet, structural carbon and structural silicon steel. Unless otherwise specified on the plans or in the special provisions structural carbon steel shall be used where structural steel is specified, and structural rivet steel for all rivets.

Structural carbon and eyebar steel shall conform to the requirements of the Standard Specifications for Steel for Bridges, serial designation A 7-34, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

Structural rivet steel shall conform to the requirements of the Standard Specifications for Structural Rivet Steel, serial designation A 141-33, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

Structural silicon steel shall conform to the requirements of the Standard Specifications for Structural Silicon Steel, serial designation A 94-33, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society. All parts of silicon steel shall be identified by paint marks and stamping at the mill and those identification marks with some characteristic painting shall be retained throughout the work of fabrication so that there may be no mistakes in the use of silicon steel parts where required.

(b) *Limits of Surface Imperfections.* Structural sections shall be rejected if the surface imperfections exceed the limits noted herein. If the imperfections are within the limits noted herein, the following method of correction is to be employed:

Surface imperfections shall be removed by means of chipping to whatever depth is necessary to reach sound metal. There shall not be removed by chipping more than one and one-half (1.5) per cent of the nominal cross-sectional area, and the depth of the chipping shall not exceed the limits tabulated below:

1/16″ deep in base metal which is 0.375 to 0.499 thick

1/8″ deep in base metal which is 0.500 to 0.999 thick

1/4″ deep in base metal which is 1.000 to 1.999 thick

3/8″ deep in base metal which is 2.000 to 3.499 thick

No chipping is allowed in base metal less than 0.375″ in thickness.

Surface imperfections shall not exceed, in a continuous chipping, the length given in the following table for varying thicknesses of metal and maximum depths of chipping.

Table of Maximum Continuous Lengths of Chipping Permissible to Correct Surface Imperfections on Steel Shapes

Thickness of metal in inches	Maximum Depth of Chipping			
	1-16 in.	⅛ in.	¼ in.	⅜ in.
⅜	20	....	....	....
½	22	18	....	....
⅝	24	20	....	....
¾	25	21	....	....
⅞	26	22	....	....
1	27	24	19	....
1-⅛	28	26	20	....
1-¼	29	28	22	....
1-½	32	30	24	....
1-¾	35	31	27	....
2	38	34	30	20
2-¼	40	36	32	22
2-½	....	....	....	....
and up	42	38	34	24

After the imperfection has been removed inspection shall be made by the Inspector, and, unless otherwise ordered by him, weld metal shall be deposited in the depression to a thickness extending at least ⅛ inch above the rolled surface. The deposited metal shall be sound throughout and be free from excessive oxides, non-metallic inclusions and gas pockets. The weld metal shall penetrate every recess in the base metal and shall be thoroughly fused with the base metal along all surfaces and edges of fusion. The weld metal along the edges of the deposit shall merge with a gradual taper into the base metal without reentrant projection (overlap). The base metal along the edges of the removed area shall not be reduced in thickness (undercut or robbed) by the welding operation.

After the deposit has been completed, all metal projecting above the rolled surface shall be removed by chipping or grinding to produce a workmanlike finish.

Corrections of two imperfections of this character shall not be permitted directly opposite one another on the same web or flange of a steel shape.

30.3 Methods of Construction. All structural steel shall be fabricated, erected and painted as set forth on the plans and under "Steel Bridges" of these specifications.

30.4 Mill and Shop Inspection. (a) *Notice of Beginning of Work.* The Contractor shall give the Engineer ample notice of the beginning of work at the mill or in the shop, so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the Engineer has been so notified.

(b) *Facilities for Inspection.* The Contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the Inspectors shall be allowed free access to the necessary parts of the works.

(c) *Inspector's Authority.* The Inspector shall have the authority to reject any material or work which does not meet the requirements of these specifications. In case of dispute the Contractor may appeal to the Engineer, whose decision shall be final.

(d) *Mill Orders and Shipping Statements.* The Contractor shall furnish the Engineer with as many copies of mill orders and shipping statements as the Engineer may direct. The weights of the individual members shall be shown on the statements.

(e) *Facilities for Testing.* The Contractor shall furnish test specimens, as specified herein, without extra charge; also the labor, testing machines and tools necessary to make the specimens and full-size tests.

(f) *Rejections.* The acceptance of any material or finished members by the Inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

30.5 Method of Measurement and Basis of Payment. The contract unit prices for fabrication and erection of the various kinds of structural steel shall include all labor, material, transportation and shop and field painting necessary for the completion of the work in accordance with the contract.

In pound-price contracts, steel shall be paid for as follows:

(a) Structural carbon steel shall be paid for at the contract unit price for structural carbon steel.

(b) Structural rivet steel shall be paid for at the contract unit price for structural carbon steel, except as otherwsie specified herein.

(c) Structural silicon steel shall be paid for at the contract unit price for structural silicon steel. Inasmuch as members containing silicon steel, when finished in condition for weighing, also usually contain carbon and rivet steel, the exact scale weight of the silicon steel in the finished parts cannot be determined. The weight of the silicon steel paid for in pound-price contracts shall be the same percentage of the actual scale weights of the members involved, as the computed net weight of the silicon parts, not counting out rivet holes, is of the total computed net weight of the member. Members containing silicon steel shall not be weighed on the scales with members composed wholly of carbon steel.

The payment in pound-price contracts shall be based on the weight of the metal in the fabricated structure, including field rivets shipped. The weight of erection bolts, field paint, boxes, crates and other containers used for packing and materials used for supporting members during transportation, shall not be included.

Any weight in excess of one and one-half per cent above the computed weight of each individual member shall not be included in the pay weight. Weight paid for shall be shop scale weights of individual members, unless otherwise provided. If specified in the contract or permitted by the Engineer, computed weights as hereinafter provided may be made the basis of payment.

If the scale weight of any member is less than 97½ per cent of the computed weight, the member may be rejected.

Finished work shall be weighed in the presence of the Inspector if practicable. The Contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various parts.

The computed weight shall be obtained by the use of the following rules and assumptions:

(a) The weight of steel shall be assumed at 490 pounds per cubic foot.

(b) The weights of rolled shapes and of plates up to and including 36 inches in width shall be computed on the basis of their nominal weights and dimensions as shown on the approved shop drawings, deducting for copes, cuts and open holes. To the nominal weights of plates more than 36 inches in width there shall be added one-half of the allowed percentage of over-run in weight given in the Standard Specifications for Steel for Bridges, serial designation A 7-34 of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society.

(c) The weight of heads of shop-driven rivets shall be included in the computed weight, assuming the weights to be as follows:

Diameter of Rivet	Weight per 100 heads, pounds
½ inch	4.0
⅝ inch	7.5
¾ inch	12.5
⅞ inch	18.5
1 inch	27.0

(d) To the total computed weight of metals may be added 0.4 of 1 per cent as an allowance for shop paint.

SECTION 31.

PHOSPHOR BRONZE AND BRONZE BEARING PLATES.

31.1 Description. Phosphor bronze or bronze bearing plates, conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed.

31.2 **Material.** Phosphor bronze and bronze bearing plates shall meet the requirements for bronze bearing metals for turntables and movable railroad bridges, serial designation B22-21, (Class B), of the American Society for Testing Materials with subsequent amendments and additions thereto adopted by the Society. Bronze castings shall be free from inclusions of foreign material, casting faults, injurious blowholes or other defects rendering them unsuitable for the service intended.

31.3 **Methods of Construction.** Bearing plates shall be accurately set in correct position as shown on the plans and shall have uniform bearing over the total area. They shall be securely anchored to the concrete with bolts set in the concrete of the size and as shown on the plans. Sliding surfaces shall be planned parallel to the movement of the spans and polished and shall be thoroughly coated with graphite and grease just before being placed in position, and special care shall be taken to avoid placing concrete in such a manner as to interfere with their free action.

31.4 **Basis of Payment.** Payment will be made at the contract unit price bid per pound for phosphor bronze or bronze bearing plates complete in place, which price will be full compensation for furnishing material including bolts, all equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 32.

CAST STEEL ROCKERS AND BEARING PLATES.

32.1 **Description.** Cast steel rockers and bearing plates, conforming to these specifications, of the sizes, and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed.

32.2 **Material.** Steel castings shall conform to the requirements of the standard specifiations for steel castings, serial designation A 27-24, of the American Society for Testing Materials, with subsequent amendments and additions thereto adopted by the Society, and supplemented by the following: Unless otherwise specified all castings shall be class B, medium grade.

32.3 **Construction Methods.** Rockers and bearing plates shall be accurately set and shall have uniform bearing over the total area. For a description of the method to be followed in setting bearing plates see "Steel Bridges." Rockers shall not be permanently set until after the bridge floor has been placed and then only after making due allowance for temperature.

32.4 **Method of Measurement and Basis of Payment.** The weight of castings shall be computed from the dimensions shown on the approved shop drawings, with an addition of 10 per cent for fillets and over-run. Unless designated as a separate item in the proposal, payment for castings will be made at the unit price bid for structural steel in place, which price will be full compensation for furnishing material including bolts, all equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 33.

STEEL BRIDGES.

33.1 **Description.** Steel bridges shall be built as indicated on the plans and shall conform to the lines, grades, dimensions and designs shown, and in accordance with the specifications for the various items which constitute the completed structure.

33.2 **Materials.** All materials used shall be those prescribed for the several items which constitute the structure.

33.3 **Removal of Existing Structures.** Where the removal and satisfactory disposal of existing structures are required, the work shall be done as specified in the section on "Removal of Existing Structures" of these specifications.

33.4 **Excavation.** All excavation for foundations and substructures shall be performed as specified in the section on "Excavation for Structures" of these specifications.

33.5 **Placing Concrete.** All concrete shall be placed and finished as specified in the sections on "Concrete" and "Concrete Bridges and Floor Slabs" of these specifications.

33.6 Fabrication. Structural steel shall be fabricated in accordance with the following requirements:

(1) *Drawings.* The construction plans shall consist of shop details, erection and other working plans showing details, dimensions, size of material and other information and data necessary for the complete fabrication and erection of the metal work. Approval of construction plans shall be secured before fabrication of steel work is commenced.

The Contractor shall furnish the Engineer with prints of the shop drawings in quadruplicate for approval, and after approval he shall furnish three or more prints, as required, of the approved drawings. Upon completion of the work the original tracings, if required shall be supplied to the Engineer. No deviation from the approved plans shall be permitted without a written order from the Engineer.

Changes on approved drawings shall be subject to the approval of the Engineer, and he shall be supplied with a record of such changes.

Substitutions of sections different from those shown on the drawings shall be made only when approved in writing by the Engineer.

(2) *Workmanship and Finish.* The workmanship and finish shall be equal to the best practice in modern bridge shops. Shearing and clipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished.

(3) *Storage of Materials.* Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease or other foreign matter, and shall be protected as far as practicable from corrosion.

(4) *Straightening Material.* Rolled material before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends may be cause for rejection of the material.

(5) *Punched Work.* If general reaming is not required, all main material, forming parts of a member composed of not more than five thicknesses of metal, may be punched with a punch 1-16 inch larger than the nominal size of the rivets, whenever the thickness of the metal is not greater than three-fourths inch. When there are more than five thicknesses, or when any of the main material is thicker than three-fourths inch, all of the holes shall be punched with a punch 3-16 inch smaller and after assembling reamed 1-16 inch larger than the nominal size of the rivets, except that when the metal is thicker than the size of the rivet, the holes shall be drilled.

(6) *Punched Holes.* Holes punched full-size shall be 1/16 inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than 3/32 inch. Holes shall be clean cut and without torn or ragged edges.

(7) *Accuracy of Punched Holes.* The punching of holes shall be done so accurately that, after assembling the component parts of a member, a cylindrical pin ⅛ inch smaller than the nominal diameter of the punched hole may be passed through at least 75 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes. If this requirement is not fulfilled, the badly punched pieces may be rejected. If ten per cent of any group of 100 or fewer holes will not pass a pin 3/16 inch smaller than the nominal diameter of the punched holes, the mispunched pieces may be rejected.

(8) *Reamed Work.* General reaming will be required if provided for in the contract.

If general reaming is required, holes shall be sub-punched and reamed in material forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes may be punched full-size in material used for lateral, longitudinal and sway bracing, lacing bars, stay plates, and diaphragms, not forming a part of the section of main members if the thickness of the material is not greater than the nominal diameter of the rivet. Holes shall be drilled in material the thickness of which is greater than the nominal diameter of the rivet.

(9) *Sub-Punched Holes.* Sub-punched and reamed holes for rivets having diameters greater than ¾ inch shall be punched 3/16 inch smaller than the nominal diameter of the rivet. For rivets having diameters of ¾ inch, the holes shall be punched 11/16 inch in diameter. For rivets having diameters of ⅝ or less, the holes shall be punched full size and spear-reamed. The punch and die shall have the same relative size as specified for full-size punched holes.

(10) *Reaming.* After assembling, sub-punched holes shall be reamed to a diameter 1/16 inch larger than the nominal diameter of the rivet.

Reaming shall be done after the pieces forming a built member are assembled and firmly bolted together. Reamed parts shall not be interchanged.

Reaming of rivet holes shall be done with twist drills or with short taper reamers. Reamers preferably shall not be directed by hand. If oil or grease is used as a lubricant when reaming, it shall be applied so as not to soil the surfaces which are to be painted. Burrs resulting from reaming shall be removed.

(11) *Drilled Holes.* Drilled holes shall be 1/16 inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed. If members are drilled while assembled, the parts shall be held securely together while the drilling is being done.

(12) *Accuracy of Reamed and Drilled Holes.* Reamed or drilled holes shall be cylindrical and perpendicular to the member. After reaming or drilling, 85 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes, shall not show an offset greater than 1/32 inch between adjacent thicknesses of metal.

(13) *Shop Assembling.* Surfaces of metal in contact shall be cleaned before assembling.

The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operations. The member shall be free from twists, bends, and other deformation.

Preparatory to the shop riveting of full-size punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not be more than 3/32 inch larger than the nominal diameter of the rivets.

End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct position and bolted, clamped, or otherwise firmly held in place until riveted.

Parts not completely riveted in the shop shall be secured by bolts in so far as practicable to prevent damage in shipment and handling.

(14) *Drifting of Holes.* The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit rivets, they shall be reamed.

(15) *Reaming of Field Connections.* If general reaming is required, riveted trusses and skew portals shall be assembled in the shop, the parts adjusted to line and fit, and holes for field connections drilled or reamed while so assembled. Holes for other field connections, except those in lateral, longitudinal, and sway bracing, shall be drilled or reamed in the shop with the connecting parts assembled, or else drilled or reamed to a metal template without assembling.

If provided in the contract, the field connections in punched work, except those for lateral, longitudinal and sway bracing, shall be reamed to a metal template or else with the parts assembled.

(16) *Match-Marking.* Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the Engineer.

(17) *Rivets.* Rivets, before driving, shall be of the diameter specified. They shall be free from furnace scale.

Rivet heads shall be of approved shape, concentric with the shank, true to size, full, neatly formed, and free from fins.

(18) *Field Rivets.* Field rivets shall be furnished in excess of the nominal number required to the amount of ten per cent plus ten rivets for each diameter and length.

(19) *Field Bolts.* Bolted connections shall not be used unless specifically authorized. If bolted connections are permitted, the bolts shall be unfinished bolts or turned bolts, as specified. Bolts shall have hexagonal heads and nuts, and shall be of such length that they will extend entirely through the nut but not more than one-quarter inch beyond. Bolts in tension shall have two nuts.

Unfinished bolts in shear shall have not more than one thread within the grip. The diameter of the unfinished bolts shall not be more than 1/16 inch smaller than the diameter of the hole.

The threads of turned bolts shall be entirely outside the grip. The bolts shall be given a finishing cut. Approved nut locks or flat washers one-fourth inch thick shall be furnished, as specified. The holes for turned bolts shall be reamed and their diameters shall be not more than 1/32 inch greater than the diameter of the finished bolt.

(20) *Riveting.* Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale, and other adhering matter. When driven, they shall completely fill the holes. The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins, and in full contact with the surface of the member.

Loose, burned or otherwise defective rivets shall be replaced. In removing rivets, care should be taken not to injure the adjacent metal, and, if necesssary, they shall be drilled out. Caulking or recupping will not be permitted.

Rivets shall be driven by direct-acting riveters where practicable. The riveters shall retain the pressure after the upsetting is completed. If rivets are driven with a pneumatic hammer, a pneumatic bucker shall be used if practicable.

(21) *Edge Planing.* Sheared edges of plates more than ⅝ inch in thickness and carrying calculated stress shall be planed to a depth of one-fourth inch. Reentrant cuts shall be filleted before cutting.

(22) *Facing of Bearing Surfaces.* The top and bottom surfaces of steel slabs and base plates and cap plates of columns and pedestals shall be planed, or else the plates or slabs hot straightened. Parts of members in contact with them shall be faced.

Sole plates of beams and girders shall have full contact with the flanges. Sole plates and masonry plates shall be planed or hot straightened. Cast pedestals shall be planed on surfaces to be in contact with steel and shall have the surface to be in contact with masonry rough finished.

Surfaces of bronze bearing plates intended for sliding contact shall be finished.

In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of the expansion.

(23) *Abutting Joints.* Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed one-fourth inch.

(24) *End Connection Angles.* Floorbeams, stringers, and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall be not less than that shown on the detail drawings.

(25) *Lacing Bars.* The ends of lacing bars shall be neatly rounded unless another form is required.

(26) *Finished Members.* Finished members shall be true to line and free from twists, bends and open joints.

(27) *Web Plates.* In girders having no coverplates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than ⅛ inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be one-half inch less in width than the distance back-to-back of flange angles.

At web splices, the clearance between the ends of the web plates shall not exceed ⅜ inch. The clearance at the top and bottom ends of web splice plates shall not exceed ¼ inch.

(28) *Fit of Stiffeners.* End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within ¼ inch at each end.

(29) *Eye-Bars.* Eye-bars shall be straight, true to size, and free from twists, folds in the neck and head and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eye-bars are made, if they are satisfactory to the Engineer. The thickness of the head and neck shall not over-run more than 1/16 inch.

Eye-bars that are to be placed side by side in the structure shall be bored so accurately that upon being placed together, pins 1/32 inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

(30) *Annealing.* Before boring, eye-bars shall be annealed to produce the required physical qualities and shall be straightened. Proper instruments shall be provided for determining at any time the temperature of the bars.

Other steel that has been heated partially shall be annealed, unless it is to be used in minor parts. Crimped stiffeners need not be annealed.

(31) *Pins and Rollers.* Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. The final surface shall be produced by a finishing cut.

Pins more than 7 inches in diameter shall be forged and annealed.

In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along the axis.

(32) *Boring Pin Holes.* Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside-to-outside of holes in tension members and inside-to-inside of holes in compression members shall not vary from that specified more than 1/32 inch. Boring of holes in built up members shall be done after the riveting is completed.

(33) *Pin Clearances.* The diameter of the pin hole shall not exceed that of the pin by more than 1/50 inch for pins 5 inches or less in diameter, or 1/32 inch for larger pins.

(34) *Welds.* Welding of steel shall not be done except to remedy minor defects and then only with the approval of the Engineer.

(35) *Screw Threads.* Screw threads shall make close fits in the nuts and shall be U. S. Standard, except that for pin ends of diameters greater than 1½ inches, they shall be made with six threads to the inch.

(36) *Pilot and Driving Nuts.* One pilot nut and one driving nut for each size of pin shall be furnished, unless otherwise specified.

(37) *Upset Ends.* Bars with screw ends shall be upset so that the area at the root of the thread will be at least fifteen (15) per cent larger than in the body of the bar. Closed sleeve nuts shall not be used.

33.7 Mill and Shop Inspection. Materials are subject to inspection as set forth under "Structural Steel" of these specifications.

33.8 Shop Painting. (a) *General.* The painting of metal structures shall include, unless otherwise provided in the contract, the preparation of the metal surfaces, the application, protection, and drying of the paint coatings, and the supplying of all tools, tackle, scaffolding, labor and materials necessary for the entire work.

(b) *Paint.* The paint shall be red lead paint meeting the requirements of the "Shop Coat" set forth elsewhere in these specifications.

(c) *Mixing of Paint.* Paint shall be thoroughly mixed before applying, and the pigments shall be kept in suspension.

(d) *Weather Conditions.* Paint shall not be applied when the air temperature is below 40° F., or when the air is misty, or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work. It shall not be applied upon damp or frosted surfaces.

Material painted under cover in damp and cold weather shall remain under cover until dry or until weather conditions permit its exposure in the open. Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

(e) *Application.* Painting shall be done in a neat and workmanlike manner. Brushes preferably shall be round or oval in shape, but if flat brushes are used they shall not exceed 4 inches in width.

The paint when applied shall be so manipulated under the brush as to produce a uniform, even coating in close contact with the metal or with previously applied paint and shall be worked into all corners and crevices.

On surfaces which are inaccessible to paint brushes, the paint shall be applied with sheepskin daubers especially constructed for the purpose.

(f) *Removal of Paint.* If the painting is unsatisfactory to the Engineer, the paint shall be removed and the metal thoroughly cleaned and repainted.

(g) *Thinning Paint.* If it is necessary in cool weather to thin the paint on account of congealing, this shall be done only by heating.

(h) *Cleaning.* Surfaces of metal to be painted shall be thoroughly cleaned, removing rust, loose mill scale, dirt, oil or grease, and other foreign substances. The removal of rust, scale, and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers; or other effective means. Oil and grease shall be removed by the use of gasoline or benzine. Bristle brushes shall be used for removing loose dust.

(i) *Contact and Inaccessible Surfaces.* Surfaces to be riveted in contact either in the shop or field shall not be painted. Surfaces not in contact but which will be inaccessible after assembly or erection shall be painted two coats.

(j) *Shop Painting.* When fabrication is complete and the work has been accepted, surfaces not painted before assembling, except surfaces to be in contact after erection, shall be painted one coat. Material shall not be loaded for shipment until the paint is dry.

(k) *Erection Marks.* Erection marks shall be painted on painted surfaces.

(l) *Machine-Finished Surfaces.* With the exception of abutting chord and column splices and column and truss shoe bases, machine-finished surfaces shall be coated as soon as practicable after being accepted, and before removal from the shop, with a hot mixture of white lead and tallow. Surfaces of iron and steel castings machine-finished for the sole purpose of removing scales, scabs, fins, blisters or other surface deformations shall be given the shop coat of paint.

The composition used for coating machine-finished surfaces shall be mixed in the following proportions: 4 pounds tallow, 2 pounds white lead, and 1 quart linseed oil.

33.9 **Weighing, Marking and Shipping.** (a) *Weighing of Members.* Finished work shall be weighed in the presence of the Inspector, if practicable.

The Contractor shall supply satisfactory scales and shall do the handling and weighing.

(b) *Marking and Shipping.* Members weighing more than 3 tons shall have the weight marked thereon. Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts, and small packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs, or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each package.

Anchor bolts, washers, and other anchorage or grillage materials, shall be shipped in time to suit the requriements of the masonry construction.

(c) *Handling Material.* The loading, transportation, unloading, and storing of structural material shall be conducted so that the metal will be kept clean and free from injury.

33.10 **Erection.** The Contractor shall erect the metal work, remove the temporary construction, and do all the work required to complete the bridge or bridges as covered by the contract, including the removal of the old structure or structures if stipulated, all in accordance with the plans and these specifications.

(a) *Masonry.* If the substructure and superstructure are built under separate contracts, the Purchaser will provide the masonry, constructed to correct lines and elevations and properly finished, and will establish the lines and elevations required for setting the steel.

(b) *Plant.* The Contractor shall provide the false-work and all tools, machinery, and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work. Temporary structures or falsework placed by the Purchaser, if suitable, may be used by the Contractor.

(c) *Handling and Storing Materials.* Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and

shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. The Contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or injury discovered. He shall be responsible for the loss of any material while in his care, or for any damage resulting from his work.

(d) *Falsework.* The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor, if required, shall prepare and submit to the Engineer for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

(e) *Methods and Equipment.* Before starting work, the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the Engineer.

(f) *Bearings and Anchorage.* Masonry bearing plates shall not be placed upon bridge-seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the Engineer, they shall be placed on a layer of canvas and red lead applied as follows:

Thoroughly swab the bridge-seat bearing area with red lead paint and place upon it three layers of 12 to 14 ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic.

In setting shoes or bearing plates for steel truss spans proper allowance shall be made for bottom chord elongation due to dead load.

Anchor bolt holes shall be drilled in correct locations vertically to the plane of the bridge seat, and the anchor bolts set in Portland cement grout therein. Anchor bolts shall first be dropped into the dry holes to assure their proper fit after setting. They shall then be set as follows: Fill the holes about two-thirds full of grout and by a uniform, even pressure or by light blows with a hammer, (flogging and ramming will not be permitted) force the bolt down until the grout rises to the top of the hole and the anchor bolt nut rests firmly against the metal shoe or pedestal. Remove all excess grout which may be flushed out of the hole, to permit proper field painting of the metal surfaces.

The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

Anchor bolts which are to be set in the masonry prior to the erection of the superstructure shall be carefully set to the proper location and elevation with templates or by other suitable means.

(g) *Straightening Bent Material.* The straightening of plates and angles or other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the Engineer, in which case the heating shall not be to a higher temperature than that producing a dark cherry-red color. After heating, the metal shall be cooled as slowly as possible.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

(h) *Assembling Steel.* The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members shall not be driven until the span has been swung. Rivets in railings shall not be driven until the span has been swung and the deck placed. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

Fitting up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be 1/32 inch larger.

(i) *Riveting.* Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the Engineer. Rivets larger than ⅞ inch in diameter shall not be driven by hand. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out. Field driven rivets shall be inspected and accepted before being painted.

(j) *Bolted Connections.* In bolted connections, the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

(k) *Pin Connections.* Pilot and driving nuts shall be used in driving pins. They shall be furnished with the steel work and shall be returned to the purchaser on completion of the work. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

(l) *Misfits.* Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered a legitimate part of the erection. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Inspector, and his approval of the method of correction obtained. The correction shall be made in the presence of the Inspector, who will check the time and material. The Contractor shall render within thirty days an itemized bill for such work of corrections for the approval of the Engineer.

(m) *Removal of Old Structure and Falsework.* If stipulated in the contract, the Contractor shall dismantle the old structure and dispose of it as stipulated in these specifications under the "Removal of Existing Structures."

Upon completion, and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged and restore in acceptable manner all property, both public and private, which may have been damaged during the prosecution of his work, and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

(n) *Inspection.* The work shall be subject at all times to inspection by the Engineer.

33.11 **Laws and Permits.** The Contractor shall comply with Federal, State and local laws, regulations, and ordinances, and shall obtain, at his own expense, the necessary permits for his operations.

33.12 **Field Painting.** The requirements of "Shop Painting" shall also apply to field painting, with the exception of the type of paint, which shall be as specified on the plans and shall meet the requirements of "Field Coats" set forth elsewhere in these specifications.

(a) *Protection of Traffic.* The Contractor shall protect pedestrians, vehicular and other traffic upon or underneath the bridge and also all portions of the bridge superstructure and substructure against damage or disfigurement by spatters, splashes and smirches of paint or paint materials.

(b) *Number of Coats and Type of Paint.* Unless otherwise specified, field painting shall consist of two coats applied after erection.

The type of paint to be used will be specified on the plans.

(c) *Field Painting.* As soon as the field cleaning has been done to the satisfaction of the Inspector, the heads of field rivets and bolts, and any surfaces from which the shop coat of paint has been worn off or has become otherwise defective, shall be covered by one coat of the same paint as was used in the shop.

When the paint applied for touching up rivet heads or abraded surfaces has become dry, the first field coat may be applied. In no case shall a coat be applied until the previous coat has dried throughout the full thickness of the paint film.

To secure a maximum thickness of paint film on rivet heads and edges of plates, angles, and other rolled shapes, these parts shall be painted an extra coat in advance of the general application of each field coat.

Small cracks and cavities which have not been sealed in a watertight manner by the first field coat shall be filled with red lead paste before the second field coat is applied.

33.13 Design. Steel bridges shall be designed in accordance with the specifications set forth in the "Design Specifications for Highway Structures."

33.14 Methods of Measurement. The quantities of the various items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing by the Engineer.

33.15 Basis of Payment. The measured quantities, as provided above, will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all materials and for all labor, tools, equipment and incidentals necessary to complete the work. Such payment shall constitute full payment for the completed structure ready for use. Miscellaneous items not listed in the proposal but shown or billed on the drawings shall be included in the price bid for the other items. No additional allowances will be made for cofferdam construction, falsework, form lumber or other erection expense.

SECTION 34.

TIMBER STRUCTURES.

34.1 Description. All timber structures shall be built as indicated on the plans, conforming to line, grade, and dimensions shown, and in accordance with the specifications for piling, concrete, untreated timber, treated timber, wearing top, and other items which constitute the complete structure.

34.2 Material. (a) *General.* Unless otherwise specified, timber or lumber shall be full sawn intermountain red fir (Pseudotsuga taxifolia), western larch (Larix occidentalis), Pacific coast Douglas fir (Pseudotsuga taxifolia), or any equivalent product.

In treated timber trestles all lumber except rails and rail posts shall be Pacific coast Douglas fir.

(b) *Grades.* The structural grades of lumber permitted under these specifications are dense select structural grade, select structural grade, and select merchantable grade. These structural grades are further divided on the basis of use, size, and limiting characteristics, into three subgrades, namely, posts and timbers; framing, joists, planks, and small timbers; and stringers, girders, beams, etc. These subgrades will be referred to herein as post and timber, joist and plank, and stringer and girder.

All lumber shall be graded and the defects thereof defined in accordance with the "Standard Grading and Dressing Rules" of the West Coast Lumbermen's Association, Book No. 10, dated July 1, 1934, with subsequent amendments adopted by the association, unless otherwise noted herein. The paragraphs of these rules which apply specifically to the structural grades of timber required herein are:

Dense select structural grade, paragraphs 210, 214, 218 and 302. (Stringers and caps shall be dense select structural grade and shall be stringer and girder subgrade, all as defined in paragraphs 218 and 302.)

Select structural grade, paragraphs 210, 214 and 218.

Select merchantable grade, paragraphs 194, 199 and 203. (All lumber in trestles except as noted for stringers and caps, shall be select merchantable grade.)

In any event, all lumber shall be free from decayed or unsound portions or any other defects whatever that might impair its strength and durability.

(c) *Size Requirements.* Post and timber grades shall have nominal dimensions six inches by six inches and larger. Joist and plank grades shall have nominal thicknesses from two inches to four

inches and nominal widths four inches and larger. Stringer and girder grades shall have nominal thicknesses fives inches and larger and nominal widths eight inches and larger.

All lumber shall be furnished rough unless otherwise specified. The words "full sawn" shall be interpreted to permit variations from nominal dimensions not to exceed the following:

Nominal Dimension	Variation
1"	1/16" under or 1/8" over
2"	1/8" under or 1/4" over
3" to 7"	3/16" under or 3/8" over
8" and over	1/4" under or 1/2" over

When surfaced lumber is specified, S1S, S2S, S1E, S2E, or S4S, it shall not be smaller in any dimension affected by surfacing than: for post and timber and stringer and girder subgrades, the nominal dimension less one-half inch; for joist and plank subgrades, the nominal dimension less three-eighths inch for nominal dimensions up to six inches, and the nominal dimension less one-half inch for nominal dimensions larger than six inches.

Standard lengths shall be in multiples of two feet.

(d) *Untreated Timber.* All untreated timber shall show at least 85 per cent heartwood on any girth.

(e) *Treated Timber.* Timber treated by a pressure method to retain 8 to 10 pounds of oil per cubic foot as hereinafter specified and so treated that all sapwood is entirely impregnated with creosote oil shall fulfill the requirements for untreated timber except there shall be no heartwood requirement.

(f) *Incising.* All sawn lumber to be treated whose least dimension is three inches or over shall be incised in a suitable power driven machine before treatment. Lumber having a thickness of four inches and over shall be incised on all four sides. Lumber less than four inches in thickness shall be incised on the wide face only, except where indicated on the drawings. The method of incising, the spacing and shape of the cutting teeth, and the depth of the incisions shall be such as to obtain a uniform penetration of the preservative conforming to the following table:

Sizes	Treatment—Lbs. per Cubic Foot of Wood					
	6 lb.	8 lb.	10 lb.	12 lb.	14 lb.	16 lb.
3 x 12	.....	1/4"	5/16"	3/8"	7/16"	1/2"
4 x 12	.....	5/16"	3/8"	7/16"	1/2"	9/16"
6 x 8	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"
8 x 10	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"
10 x 12	7/16"	1/2"	9/16"	5/8"	3/4"	3/4"
10 x 12 and larger	1/2"	9/16"	5/8"	3/4"	3/4"	3/4"

(g) *Inspection.* The work shall be subject at all times to inspection by the Engineer. The acceptance of any material or finished members by the Inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

Each shipment of lumber to be treated shall be covered by a "Certificate of Inspection" from the Pacific Lumber Inspection Bureau or the West Coast Lumbermen's Association. These certificates shall show the character, amount and sizes of material in each shipment; the grade, giving the paragraph numbers of the "Standard Grading and Dressing Rules" of the West Coast Lumbermen's Association, Book No. 10, under which the material was graded; the date of inspection and any other pertinent information. These certificates shall be filed with and approved by the Montana Highway Commission before any construction work using the lumber is begun. In cases where the shipment contains only a minor portion of the lot covered by the original "Certificate of Inspection" it will be permissible to furnish a notarized copy of the original certificate, on which shall be indicated plainly which parts of the entire lot shipment covered by the original certificate are furnished in the particular shipment in question.

Each shipment of lumber not to be treated shall, if possible, also be covered by a "Certificate of Inspection," as described for lumber to be treated. However, in case such a certificate is not furnished, the material shall be inspected at the site of the work by the Engineer.

Treated timber shall be inspected after treatment by an Inspector designated by the Engineer. The Inspector shall stamp the ends of each accepted piece with a suitable stamp which has been copyrighted by him and of which a true impression has been filed with the Montana Highway Commission. The Inspector shall also file with the Montana Highway Commission an itemized report of all timber inspected, giving temperatures, amount of preservative, time of treatment, lengths and sizes of timbers, total footage, and any other pertinent information. Treated timber which does not bear in legible form the stamp of the Inspector shall not be shipped from the creosoting plant.

34.3 Preservative Treatment. Timber to be treated for preservation shall be cut and framed prior to treatment. After treatment no unnecessary cutting of treated piles or timber will be allowed.

The range of pressure, temperature, and time duration shall be controlled so as to result in maximum penetration by the quantity of preservative injected, which shall permeate all of the sapwood and as much of the heartwood as practicable.

All treated timber in standard trestles shall receive an 8 pound empty-cell treatment for timbers over 5 inches in thickness, and a 10 pound empty-cell treatment for those less than 5 inches in thickness, and the treatment shall conform to the Standard Specifications of the American Wood Preservers Association, using either grade 1 or 2 creosote oil.

In special cases, the amount of preservative and manner of treatment shall be as indicated on the plans and shall fulfill the following requirements:

Timber shall be treated with the preservative specified by any standard full-cell process to retain not less than 10 pounds of the preservative per cubic foot or by any standard empty-cell process to retain not less than 8 pounds of the preservative per cubic foot.

The preservative shall be one of the following grades of creosote oil or creosote coal-tar solution as directed by the Engineer, or indicated on the plans, and shall meet the following requirements:

Preservative	Creosote Oil		Creosote coal-tar solution
	Grade 1	Grade 2	
It shall not contain water in excess of	3%	3%	3%
It shall not contain matter insoluble in benzol in excess of	0.5%	0.5%	2%
Specific gravity of oil at 38°/15.5° C. shall not be less than	1.03	1.03	1.05—1.12
The distillate based on water-free-oil shall be within the following limits:			
Up to 210° C. not more than	5%	8%	5%
Up to 235° C. not more than	25%	35%	25%
The float test of residue above 355° C. shall not exceed 50 sec. at 70° C. If the distillation residue above 355° C. exceeds	5%	5%	26%
Coke residue of oil not more than	2%	2%	6%

The foregoing tests shall be made in accordance with standard methods of the American Association of State Highway Officials (tentative method T-60).

34.4 Bridge Iron. Steel-truss rods, structural shapes, and plates shall conform to the requirements of the Standard Specifications for Steel for Bridges of the American Society for Testing Materials, serial designation A7-34. No welds in truss rods will be permitted. All plates or shapes which are heated to facilitate bending shall be properly annealed. Steel castings shall conform to the requirements of the standard specifications for steel castings of the American Society for Testing Materials, serial designation A27-24, and shall be class B medium grade. Iron castings shall conform to the requirements of the standard specifications for gray iron castings of the American Society for Testing Materials, serial designation A48-32T.

34.5 Method of Construction. (a) *Handling of Materials.* Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

(b) *Treatment of Breaks.* All places where the surface of treated timber is broken by the cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar.

(c) *Bearing.* Post and pile caps shall be level and have full even bearing on all posts or piles in the bent and be secured to each pile or post by ¾-inch diameter drift bolt extending at least 9 inches into the pile or post.

(d) *Framing.* Truss and bent timbers shall be accurately cut, and framed to a close fit in such a manner that they will have even bearing over the entire contact surface of the joint. No blocking or shimming of any kind will be allowed in making joints, nor will open joints be accepted. Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

(e) *Bolt Holes.* All bolt holes shall be bored with an auger 1/16 inch smaller in diameter than the diameter of the bolt, except in thin seasoned timbers, (such as handrails) where tight fit bolts will cause undesirable cracks; then the auger shall be the same size as the diameter of the bolt. Hot creosote oil shall be poured into the bolt holes of treated timber before insertion of the bolts in such a manner that the entire surface of the holes shall receive a coating of the oil. Holes for tension rods shall be bored with an auger 1/16 inch larger in diameter than the diameter of the rod and the hole after the insertion of the rod shall be effectively sealed with hot tar or other suitable waterproof material. Mortises and tenons shall be draw bored.

(f) *Stringer Sizing.* Stringers shall be sized at bearings. Outside stringers may have butt joints but interior stringers shall be framed to bear over the full width of floorbeam or cap at each end. The ends shall be separated at least one-half inch for the circulation of air and shall be securely fastened to the timber on which they rest.

(g) *Roadway Floors.* Roadway floors shall be of the strip or laminated type. Floor plank shall have a nominal thickness of 2 inches and the width shown on the plans and the length shall be the full width of the roadway. Unless otherwise specified, they shall be sized on one edge to a uniform width and shall not vary in thickness from end to end. Planks shall be laid with the surfaced edge down and each 2-inch piece shall be toenailed to each alternate stringer with 20d nails. In addition each piece shall be nailed horizontally to adjacent pieces with 40d nails at 18 inches center to center and staggered both horizontally and vertically with nails in adjacent pieces. All floors shall be cut to a straight line along the sides of the roadway.

(h) *Waterproofing Deck.* After laminated decking is laid, and curbs, with drains as specified, are completed, the entire top surface of deck and the inside surfaces of curbs, shall be treated with three coats of hot tar conforming to requirements set forth in the American Society for Testing Materials, serial designation D108-30, with subsequent amendments and additions thereto adopted by the Society.

The tar shall be heated in an open tank or kettle to a temperature between 200 and 225 degrees Fahrenheit, and then applied evenly to the surfaces to be treated at the rate of ¼ gallon per square yard. Three coats shall be applied at this rate, each coat being given a sufficient time to cool and set up before the application of the succeeding coat is begun.

The cost of all materials, equipment and labor necessary and incidental to this waterproofing of the deck, as well as the materials and labor incidental to the construction of the drain openings in curbs, shall be included in the price bid per thousand feet board measure for treated lumber in place.

(i) *Wheel Guards.* Wheel guards shall be constructed as shown on the plans and shall be bolted to the outside stringers by ¾-inch machine or hook bolts spaced not more than 5 feet center to center. All joints shall be lapped and a bolt shall pass through each lapped joint. When the wheel guard is not blocked up from the floor, drain holes shall be provided at such intervals as to drain the roadway adequately. They shall be provided with galvanized iron lining and arranged so as to discharge free of the structure.

(j) *Railing.* Railings shall be built as shown on the plans and shall be constructed in a workmanlike and substantial manner. Unless otherwise noted, all railing material shall be untreated and dressed on four sides. All rails shall be squarely butt-jointed at the posts and the rails shall break joints.

(k) *Bolts.* Bolts shall be of the sizes specified and must be perfect in every respect. They shall have square or carriage heads and square nuts, and screw threads shall make close fits in the nuts. All bolts shall be effectively checked after the nuts are adjusted.

(l) *Washers.* Washers shall be used between all bolt heads and nuts and the wood. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For malleable or plate washers, the diameter or side size of the square shall be equal to four times

and the thickness equal to one-half the diameter of the bolt. Cast iron washers shall be used when the timber is in contact with earth.

(m) *Galvanized Hardware.* When galvanized hardware is specified on the plans, all hardware, including nails, spikes, bolts, nuts, washers, and uplift straps shall be galvanized by the Hot Dip Method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to the surfaces, and it shall be capable of withstanding four (4) immersions in a standard test solution of copper sulphate without showing any trace of metallic copper on the steel in accordance with the Preece Test. The first three (3) immersions shall be for a period of one minute each and the fourth (4th) immersion for a period of one-half minute.

34.6 Painting Untreated Timbers. In structures of untreated timber, the following surfaces shall be thoroughly coated with a thick coat of red lead paint before assembling: Ends, tops and all contact surfaces of pile caps, floorbeams, and stringer ends, joints, and all contact surfaces of truss members, laterals and braces. The back face of bulkheads and all other timber in contact with earth shall be thoroughly coated with two coats of red lead paint, hot tar, hot asphaltum, or hot creosote coal-tar solution. Timber bumpers at the end of concrete spans shall be painted on all faces with two coats of hot creosote coal-tar solution after all holes have been bored and the timber shaped to fit the crown of the roadway.

Unless otherwise specified, handrailing and posts shall be painted with three coats of paint conforming to the specifications for paints for woods as hereinafter set forth in Section 53.

All timber to be painted must be seasoned, and painting shall be done only when the timber is free from frost and the surface is perfectly dry and clean. No painting shall be done in wet or freezing weather. All paint shall be thoroughly dry before applying the succeeding coats. It shall be applied in good heavy coats, completely covering every part of the surface and shall be well worked into the joints and open spaces; it shall be so thoroughly and evenly spread that no excessive paint will collect at any point.

34.7 Design. Timber bridges will be designed in accordance with the specifications set forth in "Design Specifications for Highway Structures."

34.8 Method of Measurement. Unless otherwise provided (such as timber bumpers, see below), treated timber and untreated timber complete in place according to the plans and these specifications will be measured separately by the thousand feet board measurement. Measurements will be computed from the dimensions shown on the plans, unless changes in such dimensions have been authorized by the Engineer. Standard timber sizes will be used in computations. This measurement will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, forms, bracing, sheeting, etc. Any concrete, or any supplementary floor wearing tops shown on plans will be measured as provided in pertinent specifications.

34.9 Basis of Payment. Timber structures, except truss spans and bumpers, will be paid for by the quantities as above measured at the contract unit price per thousand feet board measure bid for untreated timber or treated timber, as the case may be, complete in place according to the plans or as directed by the Engineer, which prices shall be full compensation for all materials, hardware, equipment, tools, labor, painting, preserving treatment, and all incidentals necessary to complete the structure ready for use; provided, however, that concrete, or supplementary floor wearing tops shown on plans will be paid for as provided in the special provisions attached hereto.

Timber trusses complete will be paid for at the price bid per span complete, as shown on the plans which shall include all parts of the bridge except abutments and piers. This price shall be full compensation for all materials, structural steel, steel or iron castings, hardware, equipment, tools, labor, painting, preservative treatment, and all incidentals necessary to complete the structure ready for use; provided, however, that supplementary floor wearing tops shown on the plans will be paid for as provided in the special provisions attached hereto.

Timber bumpers at the ends of concrete spans will be paid for at the contract price bid for each wood bumper complete in place, which price shall include all material, bolts, washers, painting, preservative treatment, equipment, tools, labor, and all incidentals necessary to complete this item.

SECTION 35.

PILING.

35.1 Requirements for All Piling. Piling shall be designed to sustain the total pressure which may be transmitted to the foundation and piles shall be spaced not closer than 2 feet 6 inches center to center unless they rest on a hard stratum and act as columns. The distance from the side of any pile to the nearest edge of the footing shall not be less than 9 inches. They shall be used only in places where a minimum penetration of 10 feet in firm material, or 20 feet in soft material, can be obtained. For foundations of arch, continuous span, or movable bridges, or high abutments the piles shall be completely embedded in firm earth, sand, or gravel which will afford good lateral support. When this result is impracticable, the soft material shall be excavated from the pit and replaced by heavy riprap, for such distance and depth as the plans indicate or the engineers direct.

All excavations of the foundation in which piles are to be driven shall be complete before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles, leaving a clean, solid surface to receive the concrete.

The Contractor shall be responsible for determining the length of piles required, by driving test piles or otherwise.

When subject to transverse forces, batter piles shall be driven in sufficient numbers to resist the transverse forces without assistance from the vertical piles.

When called for on the plans, piling shall be inclosed by permanent water-tight sheet piling, the top of which shall be sawed off about 1 foot below low water.

If tests are called for on the plans or in the special provisions, the Contractor shall submit a price per test for testing piles, the number of tests to be determined by the Engineer. Tests shall be made by loading the pile to two times the working load without exceeding a permanent settlement of one-quarter inch in 48 hours unless otherwise specified. In case the safe carrying capacity of any pile is found by test or by formula if not tested, to be less than the load that it was intended to carry, additional piles shall be driven until the load per pile to be borne is reduced to safe carying capacity.

The work shall be subject at all times to inspection by the Engineer. The acceptance of any material or finished members by the Inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

35.2 Piling: Measurement and Payment. All piling will be paid for at the contract unit price bid for piling complete in place. The contract price, either per linear foot or per pile, as set forth in the proposal, shall be payment in full for all materials, equipment, temporary bracing, tools, labor and all other items necessary for driving the piles complete in place as required herein and by the plans.

If the contract is on a lineal foot basis payment will be made for only the actual number of feet of piles left in place in the completed work. No payment will be made for falsework piles or any other piles which are not driven in accordance with the specifications and plans or as ordered and made acceptable to the Engineer.

Metal driving points, when ordered, will be furnished by the Commission, unless otherwise specified, but the price per lineal foot or pile shall include all expense incidental to their use, including hauling from the designated point of delivery. Heavy riprap for lateral support in soft material or sheet piling, if required, shall be paid for under a supplemental agreement or as force account.

35.3 Untreated Timber Piling. (a) *Description.* Piling shall consist of round or square timber of the kind and dimensions specified, driven in the location and to the elevations shown on the plans or as directed, and in conformity with these specifications.

(b) *General.* Timber piles which will be below water level at all times, may be of any species of wood which will satisfactorily withstand driving.

In untreated piling for use in exposed work, the diameter of the heartwood shall be not less than 8/10 of the required diameter of the pile.

(c) *Quality.* All wood piling shall be cut from solid, sound, live trees, preferably during the winter season. The piling shall show on the butt end not less than six annual rings in the fourth inch, measured on any radial line and beginning at a point three inches from the center of the heart pith; shall be free from injurious ring shakes, rot, loose or unsound knots; and shall withstand the specified driving without splitting or excessive brooming of heads. Sound knots will be permitted provided the diameter of the knot does not exceed 4 inches or 1/3 of the diameter of the stick at the point where it occurs. Any defect or combination of defects which will impair the strength or

durability of the pile more than the maximum allowable knot shall not be permitted. Piles shall be cut above the ground swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not lie farther from the center of the pile at any point than 1 per cent of the length of the pile. Piles with short or reverse bends or kinks shall not be accepted. Piles with spiral grain which makes one complete turn in forty feet or less shall not be accepted.

Unless otherwise specified, all piles shall be peeled by removing all of the rough bark and at least 80 per cent of the inner bark. No strip of bark remaining on the stick shall be over ¾ inch wide or over 8 inches long, and there shall be at least 1 inch of clean wood surface between any two such strips. Not less than 80 per cent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile. The butts shall be sawed square and the tips shall be sawed square or tapered to a point not less than 4 inches in diameter, as directed by the Engineer.

(d) *Inspection.* Untreated timber piles shall be inspected at the site of the work by the Engineer.

(e) *Dimensions.* Round piles shall have a minimum diameter at the tip, measured under the bark, as follows:

Length of Pile.	*Tip Diameter.*
Less than 40 feet	8 inches.
40 to 60 feet	7 inches.
Over 60 feet	6 inches.

The minimum diameter of piles at a section four feet from the butt, measured under the bark, shall be as follows:

Length of Pile.	*Diameter.*	
Douglas Fir.	Southern Yellow Pine. Southern Cypress.	All Other Species.
Under 20 feet	11 inches.	11 inches.
20 to 30 feet	12 inches.	12 inches.
30 to 40 feet	12 inches.	13 inches.
Over 40 feet	13 inches.	14 inches.

The diameter of the piles at the butt shall not exceed 20 inches.
Square piles shall have the dimensions shown on the plans.

(f) *Methods of Construction.* The tops of foundation piles shall be embedded in the concrete footing at least 1 foot, and where seals of concrete deposited in water are used with piles, the piles shall project at least 6 inches above the top of the seal concrete. They shall be cut off level at such an elevation that the tops of the piles shall be always wet.

Foundation piles for framed bents shall be cut off level approximately 3 feet above the surface of the ground and the cap rigidly secured to each pile by drift bolts extending at least 9 inches into the pile.

Trestle piles shall be cut off level at the elevation shown on the plans and the caps secured as described above. If the cut-off is 10 feet or more above the ground line, timber piles shall be braced by diagonal cross bracing, secured to the piles by ¾-inch diameter through bolts.

The load per pile for foundation piles shall generally not exceed 20 tons, with a maximum limit of 25 tons. The load per pile for trestle piles and for foundation piles for trestle bents shall generally not exceed 12 tons, with a maximum limit of 15 tons.

Collars or bands to protect timber piles against splitting and brooming shall be provided where necessary.

Timber piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes of a design satisfactory to the Engineer, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

Full length piles shall always be used where practicable but if splices cannot be avoided an approved method of splicing shall be used. Piles shall not be spliced except by permission of the Engineer.

(g) *Driving.* Timber piles shall be driven with a gravity hammer, steam hammer, water jets, or a combination of water jets and hammer.

Gravity hammers for driving timber piles shall weigh not less than 2400 pounds and the fall shall be so regulated as to avoid injury to the pile and in no case shall exceed 20 feet.

Pile driver leads shall be constructed in such a manner as to afford freedom of movement to the hammer and they shall be held in position by guys or stiff braces to insure support to the pile during driving. Except where piles are driven through water, the leads preferably shall be of sufficient length so that the use of a follower will not be necessary.

Water jets may be used, either alone, or in combination with a hammer. The volume and pressure of the water at the jet nozzles, and the number of jets used, shall be sufficient to freely erode the material adjacent to the pile. If water jets and a hammer are used for driving, the jets shall be withdrawn and the piles shall be driven by the hammer to secure the final penetration. This procedure may be varied if the desired results are not obtained.

Piles shall be driven strictly in accordance with the lines and spacing shown on the plans, and not more than ¼ inch variation per foot from the vertical or from the batter line will be allowed. Timber piles shall be driven until their safe carrying capacity as determined by the following formulas is not less than 20 tons for trestle piles, and 25 tons for foundation piles, except as hereinafter specified:

For single acting steam hammers.....$P=\frac{2WH}{S+0.1}$

For double acting steam hammers.....$P=\frac{2H\ (W+Ap)}{S+0.1}$

For gravity hammers .....$P=\frac{2WH}{S+1.0}$

Where P=safe load per pile in pounds,

W=weight in pounds of striking part of hammer,

H=height of fall in feet,

A=area of piston in square inches,

p=steam pressure in pounds per sq. inch at hammer,

S=the average penetration in inches per blow for the last 10 to 20 blows for steam hammers, or 5 to 10 blows for gravity hammers.

These formulas are applicable only when

(a) The hammer has a free fall.

(b) The penetration is at a reasonably quick and uniform rate.

(c) There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.

(h) *Modification of Spacing.* In case the above carrying capacity can not be obtained, plans showing the necessary modification of the design of the footings and the number and location of the piles required shall be furnished by the Engineer.

(i) *Treatment of Piles After Cut-Off.* After driving, and the necessary cutting has been done to receive the cap, the heads of untreated timber piling used in trestle bents shall receive the same treatment as specified for the heads of treated piling.

(j) *Jetted Piles.* Jetted piles shall extend to a good solid stratum. Their carrying capacity shall be determined by actual tests or by the same method and formula as in the case of unjetted piles, provided that no jet be used during the test blows.

(k) *Basis of Payment.* Untreated timber piling will be paid for at the price bid for untreated piling.

35.4 Treated Timber Piling. (a) *Description.* Treated piling shall consist of round or square timbers of the kind and dimensions shown on plans, treated as noted on the plans and specified below, driven in the location and to the elevations shown on plans or as directed in conformity with these specifications.

Material for treated piles shall be identical with the corresponding requirements for untreated timber piling, with the additional following requirements:

Piles shall be treated with the creosote oil or creosote coal tar solution described in the specifications for timber structures.

The ranges of pressure, temperature, and time duration of treatment shall be controlled so as to result in maximum penetration of the quantity of preservative injected, which shall permeate all of the sapwood and as much of the heartwood as practicable.

For general construction, piles shall be treated to retain not less than 10 pounds of the preservative per cubic foot of wood by any full-cell process, or not less than 8 pounds by any standard empty-cell process using either grade 1 or 2 creosote oil.

(b) *Inspection.* Treated timber piles shall be inspected at the creosoting plant before treatment for grade and suitability by an Inspector designated by the Engineer. The Inspector shall stamp each pile on the butt end with a stamp which will make an impression that is readily legible after treatment. The stamp shall be copyrighted by the Inspector and a true impression filed with the Montana Highway Commission. After treatment the piles shall again be inspected by the Inspector, who shall stamp each pile on the butt end with a stamp differing from that used before treatment, and of which a true impression has also been filed with the Montana Highway Commission. The Inspector shall file with the Montana Highway Commission an itemized report of all piles inspected, giving temperatures, amount of preservative, time of treatment, lengths and sizes, total footage, and any other pertinent information. Treated timber piles which do not bear in legible form the stamps of the Inspector made both before and after treatment shall not be shipped from the creosoting plant.

(c) *Methods of Construction and Driving.* Construction methods and driving of treated timber piling shall be identical with those prescribed for untreated timber piling, with the following additional requirements applying to treated timber piling:

Treated piles and timbers shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. They shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

All places where the surface of treated piles or timbers is broken by cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar. Hot creosote oil shall be poured into the bolt holes before the insertion of the bolts in such manner that the entire surface of the holes shall receive a coating of the oil.

After the necessary cutting has been done to receive the cap, the heads of treated piles shall be given three coats of hot creosote oil. They shall then be covered with a coat of hot tar, over which will be placed a sheet of galvanized iron, or a covering may be built up of alternate layers of hot tar and loose-woven fabric similar to membrane waterproofing, using four layers of tar and three of fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large-headed nails or secured by binding with galvanized wire. After the cover is in place, the cap shall be placed and drift-bolted as prescribed under "Timber Structures."

(d) *Basis of Payment.* Treated timber piling will be paid for at the price bid for treated piling.

35.5 Concrete Piling. (a) *Description.* Concrete piles shall be made in accordance with these specifications and the designs shown on the plans or, if not shown on the plans, designs shall be submitted for approval. They shall be placed in accordance with these specifications in the location and to the elevation shown on the plans or as directed by the Engineer.

(b) *Material.* All concrete materials and their preparation and placing shall be in accordance with the requirements for Class D concrete, except that concrete for piles shall be composed of 1 part

Portland cement, 1½ parts fine aggregate, and 3 parts coarse aggregate. The maximum size of the coarse aggregate shall be 1 inch.

Reinforcement shall conform to the requirements for reinforcing steel of these specifications, and the weight and dimensions shall be as shown on plans.

Where waterproofing is to be used, special specifications will be given and the work shall be in accordance therewith.

The average diameter shall not be less than 12 inches, and the diameter at the point not less than 8 inches. The length shall not exceed 30 times the average diameter for piles driven through firm soil, and shall not exceed 15 times the average diameter for piles driven to rock through loose, wet soil or filled ground. When lateral support is deficient, so that the piles act as columns, they shall be designed as columns.

Concrete piles when properly designed, constructed, and placed may be subjected to loads as determined by tests or formula, but not to exceed 300 pounds per square inch of total cross-section at the smallest effective point and generally not to exceed 25 tons per pile, with a maximum limit of 35 tons per pile.

(c) *Method of Construction.* Precast piles shall be made in accordance with the plans, and reinforcement shall be accurately placed and rigidly secured in such manner as to insure its proper location in the completed pile. Special reinforcement at the top and bottom to protect them from damage in driving shall be provided. The centers of the main reinforcing bars shall be not closer to the surface of the concrete than 2½ inches. The concrete shall be carefully placed, tamped, and spaded, care being taken to fill ever part of the form and to work the concrete around and under the reinforcement without displacing it. The piles shall be cast separately, or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until four days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed. The concrete shall be placed continuously in each pile. The completed piles must be free from stone pockets, porous spots, or other defects, and be straight and true to the form specified. The forms shall be true to line, built of surfaced lumber and a 1-inch chamfer strip shall be used in all corners; they shall be water-tight and shall not be removed within 24 hours after the concrete is placed. All exposed surfaces of the pile shall be given a rubbed finish. The piles shall be cured at least 40 days at a temperature of not less than 40° F., or 30 days at a temperature of not less than 60° F. Piles shall be at least 30 days old when driven. When concrete piles are lifted or moved they shall be supported at the quarter points and they shall be so designed that the unit stresses produced by handling, as described above, will not exceed 650 pounds per square inch compression in concrete nor 18,000 pounds per square inch tension in steel.

(d) *Driving.* Requirements for driving large concrete piles will be covered by special provisions. Under usual conditions, that is, piles containing not over 2 cubic yards of concrete, they shall be driven with steam hammers developing not less than 12,000 foot pounds per blow at each full stroke of the piston, or with drop hammers weighing not less than the pile, with a maximum drop of 8 feet. In driving, the tops of the piles shall be protected by suitable cushions of wood, rope or other material, so placed as to reduce the injury to the pile to a minimum. Metal shoes or points of an approved design shall be used when ordered by the Engineer. Concrete piles shall be driven until their safe carrying capacity, as determined by the formula herein under "Untreated Timber Piling" is not less than 35 tons.

(e) *Modification of Spacing.* In case the above carrying capacity can not be obtained, plans showing the necessary modification of the design of the footings and the number and location of the piles required shall be furnished by the Engineer.

(f) *Jetted Piles.* Jetted piles shall extend to a good solid stratum. Their carrying capacity shall be determined by actual tests or by the same method and formula as in the case of the unjetted piles, provided that no jet be used during the test blows. Jet pipes shall not be embedded in the piles.

(g) *Piles Cast in Place.* When piles are cast in strong metal shells which have been driven in accordance with the specifications for driving concrete piles and which remain in place after the concrete has set, the safe loads for piles completely embedded in firm earth may be taken the same as specified under "Material." Piles cast in place without metal reinforcement shall not be used in water nor in ground so soft, in either wet or dry condition, as not to give firm lateral support. No pile of this type shall be concreted until all driving within a radius of 6 feet has been completed, and care shall be taken that the piles are in no way disturbed until the concrete has become hard.

(h) *Basis of Payment.* Concrete piling will be paid for at the price bid for concrete piling.

SECTION 36.

REINFORCED CONCRETE PIPE.

36.1 Description. Under this item, reinforced concrete pipe conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as directed.

Reinforced concrete pipe to be used for the construction of culverts shall be of two classes known respectively as "Standard Reinforced Concrete Pipe" and "Extra Strength Reinforced Concrete Pipe." Extra strength pipe shall be used under all embankments which are more than twenty feet in height. In case the class of pipe is not indicated on the plans or in the proposal, it shall be understood that the pipe called for is to be "Standard Reinforced Concrete Pipe."

The acceptability of pipe shall be determined by the results of strength and absorption tests hereinafter specified, if and when required, and by inspection to determine whether the pipe complies with the specifications as to design and freedom from defects.

36.2 Materials and Manufacture. (a) The reinforced concrete shall consist of Portland cement, mineral aggregate and water in which steel has been embedded in such a manner that the steel and the concrete act together in resisting forces.

Portland cement shall meet the requirements of the current Standard Specifications and Tests for Portland cement of the American Society for Testing Materials.

Reinforcement shall consist of wire which meets the requirements of the current Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement of the American Society for Testing Materials, or of bars which meet the requirements of the current Standard Specifications for Billet-Steel Concrete Reinforcement Bars of the American Society for Testing Materials

Fine aggregate shall consist of sand, stone screenings, or other inert materials with similar characteristics, or a combination thereof, having clean, hard, strong, durable, uncoated grains and free from injurious amounts of dust, lumps, soft or flaky particles, shale, alkali, organic matter, loam or other deleterious substances. Fine aggregate shall be well graded and shall pass a ¼-inch screen. Fine aggregate shall meet the requirements for fine aggregate for class "A" concrete.

Coarse aggregate shall consist of crushed stone, gravel, slag, or other approved inert materials with similar characteristics, or combinations thereof, having clean, hard, strong, durable, uncoated particles, free from injurious amounts of soft, friable, thin, elongated or laminated pieces, alkali, organic or other deleterious matter.

The aggregates shall be so graded and proportioned and thoroughly mixed with such a proportion of cement and water as will produce a homogeneous concrete mixture of such quality that the concrete will meet the test and design requirements herein specified.

(b) *Design.* Reinforced Concrete Pipe may be either bell and spigot or tongue and groove type and shall be so manufactured as to comply with the design details and strength requirements as contained in the following tables:

TABLE I

Designs of Standard Reinforced Concrete for Culvert Pipe for uniform load of 2,000 pounds per square foot. Ultimate compressive strength of concrete, 2,750 pounds per square inch (f_c = 1,030 lbs.)

Internal Diameter of Pipe in Inches "d"	Minimum Thickness of Shell in Inches	Min. Dist. Center Reinforcement to Compressive Surface in Inches "t"		Minimum Area of Circular Reinforcement, Square Inches per Lineal Foot of Pipe "A"							
				Cold Drawn Steel Wire f_s=27,500 lbs. sq. in.				Billet Steel Hard and Intermediate Grades f_s=20,000 lbs. sq. in.			
		Circular Reinforcement in Circular Pipe	Circular Reinforcement in Elliptical Pipe	Circular Reinforcement in Circular Pipe		Circular Reinforcement in Elliptical Pipe		Circular Reinforcement in Circular Pipe		Circular Reinforcement in Elliptical Pipe	
12	2	1		1 Line	.07			1 Line	.09		
15	2¼	1½	1¼	1 "	.09	1 Line	.08	1 "	.12	1 Line	.12
18	2½	1¾	1¼	1 "	.12	1 "	.10	1 "	.17	1 "	.14
24	3	1½	2	1 "	.17	1 "	.13	1 "	.25	1 "	.19
30	3½	1¾	2½	1 "	.23	1 "	.17	1 "	.32	1 "	.22
30	3½	2½	2½	2 " ea.	.17	1 "	.17	2 " ea.	.23	1 "	.22
36	4	3	3	2 " "	.20	1 "	.20	2 " "	.28	1 "	.24
42	4½	3½	3½	2 " "	.23	1 "	.23	2 " "	.32	1 "	.27
48	5	4	4	2 " "	.26	1 "	.26	2 " "	.37	1 "	.31
54	5½	4½	4½	2 " "	.30	1 "	.30	2 " "	.42	1 "	.32
60	6	5	5	2 " "	.33	1 "	.33	2 " "	.46	1 "	.36
72	7	6	6	2 " "	.40	1 "	.40	2 " "	.56	1 "	.36
84	8	7	7	2 " "	.46	1 "	.46	2 " "	.65	1 "	.65

TABLE II

Designs of Extra Strength Reinforced Concrete Culvert Pipe for uniform load of 4,000 pounds per square foot. Ultimate compressive strength of concrete, 2,750 pounds per square inch (f_c = 1,030 lbs.)

Internal Diameter of Pipe in Inches "d"	Minimum Thickness of Shell in Inches	Min. Dist. Center Reinforcement to Compressive Surface in Inches "t"		Minimum Area of Circular Reinforcement Square Inches per Lineal Foot of Pipe "A"							
				Cold Drawn Steel Wire f_s=27,500 lbs. sq. in.				Billet Steel Hard and Intermediate Grades f_s=20,000 lbs. sq. in.			
		Circular Reinforcement in Circular Pipe	Circular Reinforcement in Elliptical Pipe	Circular Reinforcement in Circular Pipe		Circular Reinforcement in Elliptical Pipe		Circular Reinforcement in Circular Pipe		Circular Reinforcement in Elliptical Pipe	
12	2½	1¼	1½	1 Line	.11	1 Line	.09	1 Line	[illegible]	[illegible]	.13
15	2¾	1⅝	1⅜	1 "	.16	1 "	.12	1 "	.21	1 "	.17
18	3⅛	1⅞	2¼	1 "	.18	1 "	.14	1 "	.29	1 "	.20
24	3⅞	2	2⅝	1 "	.26	1 "	.19	1 "	.37	1 "	.27
30	4⅝	2¼	3⅝	1 "	.36	1 "	.23	1 "	.51	1 "	.33
30	4⅝	3⅝	3⅝	2 " ea.	.23	1 "	.23	2 " ea.	.33	1 "	.33
36	5⅜	4⅜	4⅜	2 " "	.28	1 "	.28	2 " "	.40	1 "	.40
42	6	5	5	2 " "	.33	1 "	.33	2 " "	.47	1 "	.47
48	6⅝	5⅝	5⅝	2 " "	.38	1 "	.38	2 " "	.53	1 "	.54
54	7½	6½	6½	2 " "	.43	1 "	.43	2 " "	.60	1 "	.60
60	8¼	7¼	7¼	2 " "	.47	1 "	.47	2 " "	.66	1 "	.66
72	9⅝	8⅝	8⅝	2 " "	.57	1 "	.57	2 " "	.80	1 "	.80
84	11	10	10	2 " "	.67	1 "	.67	2 " "	.94	1 "	.94

TABLE III.

Designs of Extra Strength Reinforced Concrete Culvert Pipe for uniform load of 4,000 pounds per square foot. Ultimate compressive strength of concrete, 4,750 pounds per square inch. ($f_c = 1,780$ lbs.)

Internal Diameter of Pipe in Inches "ID"	Minimum Thickness of Shell in Inches	Min. Dist. Center Reinforcement to Compressive Surface in Inches "U"		Minimum Area of Circular Reinforcement Square Inches Per Lineal Foot of Pipe "A"							
				Cold Drawn Steel Wire f_s=37,500 lbs. sq. in.				Billet Steel Hard and Intermediate Grades f_s=20,000 lbs. sq. in.			
		Circular Reinforcement in Circular Pipe	Circular Reinforcement in Elliptical Pipe	Circular Reinforcement in Circular Pipe		Circular Reinforcement in Elliptical Pipe		Circular Reinforcement in Circular Pipe		Circular Reinforcement in Elliptical Pipe	
12	2	1		1 Line	.14			1 Line	.19		
15	2¼	1½	1¼	1 "	.19	1 Line	.17	1 "	.26	1 Line	.24
18	2½	1½	1½	1 "	.24	1 "	.21	1 "	.24	1 "	.29
24	3	1½	2	1 "	.35	1 "	.27	1 "	.50	1 "	.39
30	3½	1¾	2½	1 "	.47	1 "	.34	1 "	.66	1 "	.48
36	3½	2½	2½	2 " ea.	.24	1 "	.34	2 " ea.	.48	1 "	.48
36	4	3	3	2 " "	.41	1 "	.41	2 " "	.57	1 "	.57
42	4½	2½	3½	2 " "	.48	1 "	.48	2 " "	.67	1 "	.67
48	5	4	4	2 " "	.55	1 "	.55	2 " "	.76	1 "	.76
54	5½	4½	4½	2 " "	.62	1 "	.62	2 " "	.86	1 "	.86
60	6	5	5	2 " "	.68	1 "	.68	2 " "	.95	1 "	.95
72	7	6	6	2 " "	.82	1 "	.82	2 " "	1.14	1 "	1.14
84	8	7	7	2 " "	.96	1 "	.96	2 " "	1.33	1 "	1.33

TABLE IV.

Minimum Strength of Reinforced Concrete Culvert Pipe in Pounds Per Foot of Laying Length.

Size of Pipe	Standard Reinforced Concrete Culvert Pipe				Extra Strength Reinforced Concrete Culvert Pipe			
	3 Edge Bearing		Sand Bearing		3 Edge Bearing		Sand Bearing	
	Cracking Load *	Ultimate Load	Cracking Load *	Ultimate Load	Cracking Load *	Ultimate Load	Cracking Load *	Ultimate Load
12"	1,600	2,000	2,400	3,000	3,200	4,000	4,800	6,000
15"	1,800	2,500	2,700	3,750	3,600	5,000	5,400	7,500
18"	2,000	3,000	3,000	4,500	4,000	6,000	6,000	9,000
24"	2,200	4,000	3,300	6,000	4,400	8,000	6,600	12,000
30"	2,500	5,000	3,750	7,500	5,000	10,000	7,500	15,000
36"	3,000	6,000	4,500	9,000	6,000	12,000	9,000	18,000
42"	3,500	7,000	5,250	10,500	7,000	14,000	10,500	21,500
48"	4,000	8,000	6,000	12,000	8,000	16,000	12,000	24,000
54"	4,500	9,000	6,750	13,500	9,000	18,000	13,500	27,000
60"	5,000	10,000	7,500	15,000	10,000	20,000	15,000	30,000
72"	6,000	12,000	9,000	18,000	12,000	24,000	18,000	36,000
84"	7,000	14,000	10,500	21,000	14,000	28,000	21,000	42,000

* At the cracking load there shall be, in the barrel of the pipe, no crack having a surface width of .01 inch or more for a length of one foot or more.

The shell thickness and the amount of circumferential reinforcement shall not be less than that given in the design tables for the classes and sizes of pipe and the strength of concrete therein specified.

The distance from the center of the reinforcement to the nearest or tension surface of the concrete shall not be less than ¾ inch for pipe 12 inches in diameter, or less than one inch for pipe more than 12 inches in diameter.

Pipe of the internal diameters listed in the design tables shall be considered standard sizes for culvert construction. In elliptical pipe, the inside diameter at the minor axis shall be equal to the diameter of the corresponding size of circular pipe.

The ends of the pipe shall be of such design that the pipe when laid shall make a continuous conduit with a smooth and uniform interior surface.

When a single line of circular reinforcement is used in circular pipe, it shall be placed at the center of the pipe shell. When two lines of reinforcement are used in circular pipe, one shall be placed near the inner and one near the outer surface of the pipe. The single line of circular rein-

forcement in elliptical pipe shall be placed near the inner surface at the "top" and "bottom" of the pipe and near the outer surface at the sides.

Each line of circumferential reinforcement shall be assembled into a cage and have sufficient longitudinal bars or members, extending through the barrel of the pipe, to afford rigidity and maintain the reinforcement in exact shape and correct position within the form.

The reinforcement shall be lapped not less than 30 diameters or if welded, the joints shall develop the full strength of the reinforcement. The spacing center to center of adjacent rings of circumferential reinforcement in a cage shall not exceed 4 inches up to and including pipe 48 inches in diameter, nor exceed the shell thickness for larger pipe and shall in no case exceed 6 inches.

The bell shall have a circumferential reinforcement equal in unit area to that of a single line within the barrel of the pipe.

(c) *Workmanship and Finish.* Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The planes of the ends of the pipe shall be perpendicular to their longitudinal axes.

Variations of the internal diameter shall not exceed 1½ per cent nor shall the shell thickness be less than that intended in the design by more than 5 per cent at any point.

Variation in the position of the reinforcement cages shall not exceed ¼ inch from the position provided in the design, nor shall the cover on the reinforcement be less than ¾ inch at any point.

(d) *Marking.* The following shall be clearly stenciled on the pipes:

(a) The pipe class (by an "S" for Standard Pipe, and an "X" for Extra Strength Pipe).

(b) The date of manufacture.

(c) The name or trademark of manufacturer.

(d) Elliptical pipe with circular reinforcing shall have the words "Top or Bottom" clearly stenciled on the inside of the pipe at the correct place to indicate the proper position when laid.

(e) *Physical Tests.* Pipe may be tested for strength by either the three-edge or sand bearing methods as described in tentative method T-33 of the American Association of State Highway Officials.

The state shall be entitled to test a number of pipe not exceeding two per cent (2%) of the total amount required for the project and such pipe shall be furnished without cost to the State. All pipe for testing purposes shall be selected at random by the Engnieer from the stock of the manufacturer and shall be pipe which would not otherwise be rejected under these specifications. The pipe shall be free from visible moisture when tested.

By agreement between the Engineer and the manufacturer the continued acceptability of the pipe, after the preliminary pipe tests have been made, may be determined by tests of the quality of the concrete as placed in the pipe and examination of the quality, amount and the accuracy of placement of the reinforcement. The quality of the concrete shall be determined on 6 by 12-in. test cylinders taken from the concrete used in making the pipe and manufactured and cured under identical conditions with the pipe. When tested in accordance with standard methods as described in tentative method T-22 of the American Association of State Highway Officials these cylinders shall have a strength of not less than that assumed in the design of the pipe.

Pipe shall be acceptable under the strength tests when all test specimens meet the test requirements. Should less than three of ten preliminary test specimens fails to meet the test requirements, then the manufacturer will be allowed a retest on two like specimens for each specimen that failed, and the pipe shall be acceptable only when all of these retest specimens meet the test requirements. No further retests shall be permitted.

Tests for absorption shall be made in accordance with the method described in tentative method T-33 of the American Association of State Highway Officials.

The absorption shall not exceed 8% for test specimens taken from pipe designed to be made of concrete having a compressive strength of 3,000 or more pounds per square inch, or 9% for test specimens taken from pipe designed to be made of concrete having a compressive strength of less than 3,000 pounds per square inch. Pipe shall be considered to meet these specifications, for absorption, when not less than 80% of the number of specimens tested, including any retested, meet the test requirements. When the initial absorption specimen from a pipe fails to meet these specifications, the absorption test shall be made on another specimen from the same pipe and the results of the retest shall be submitted for the original test results.

Pipe will be considered ready for shipment when they meet the test requirements, or when tests of 6 by 12-in. cylinders show that the concrete has attained the strength assumed in the design of the pipe.

Every manufacturer furnishing pipe under these specifications shall furnish all facilities necessary to carry out the tests herein provided.

(f) *Inspection.* All materials, processes of manufacture and finished pipe shall be subject to inspection and approval by the Engineer. The manufacturer when so directed by the Engineer shall have holes cut in such sections of the finished pipe (not exceeding one hole in every 50 sections delivered) as desired so that a proper inspection may be made of the quantity and placement of the reinforcement. If the pipes are tested for strength or absorption, inspection of the reinforcement shall be made on the pipe used for those tests, and in no case shall the total number of pipe cut open for inspection of reinforcement exceed the number to which the State is entitled under the provisions of Section 36.2 (e).

Pipe shall be subject to rejection on account of failure to meet any of the specification requirements or on account of the following:

(1) Fractures or cracks passing through the shell, except that an end crack that does not exceed the depth of the joint, or a fracture that at its deepest point does not exceed the depth of the joint nor extend more than ten per cent around the circumference shall not be considered cause for rejection unless these defects exist in more than five per cent of the pipe inspected.

(2) Defects which indicate imperfect mixing and moulding.

(3) Hand patching of pipe after being removed from moulds.

(4) Evidence that reinforcing material is too close to surface of pipe.

All rejected pipe shall be plainly marked by the Inspector and shall be replaced by the manufacturer with pipe which meets the requirements of these speciifcations

36.3 Construction Methods. Excavation shall be made to the required depth and grade and the bottom of the trench shall be shaped to conform to the shape of the pipe and shall afford a uniformly firm and true bed throughout its length. If a bell and spigot type of pipe is used, a recess shall be excavated to receive the bell. Where rock is encountered, the trench shall be excavated to a depth of at least four (4) inches below the grade established for the pipe and shall be backfilled with thoroughly tamped fine material.

The pipe shall be laid with the bell or groove end upgrade and all joints shall be caulked and filled with mortar composed of one (1) part of cement and two (2) parts of fine aggregate. Before succeeding sections of pipe are laid, the lower portion of the hub of the preceding pipe shall be plastered on the inside with mortar of sufficient thickness to bring the inner surface of abutting pipes even. After the pipe is laid the remainder of the joint shall be filled with mortar, and sufficient additional mortar shall be used to form a beard around the joint. The inside of the joint shall be wiped clean and finished smooth. Joints shall be thoroughly wetted before the mortar is placed. After initial set, the cement mortar on the outsied shall be protected with an earth covering.

No pipe shall be laid until the bed has been approved by the Engineer. The pipe shall be carefully laid true to line and grade. All material placed around and about the pipe shall be fine material, free from large stones, and shall be thoroughly tamped in place with an iron tamping bar.

36.4 Method of Measurement. Reinforced concrete pipe culverts shall be measured by the lineal foot of pipe complete in place.

36.5 Basis of Payment. This item shall be paid for at the contract unit price per foot bid for the different diameter of pipe, which price shall be full compensation for furnishing, hauling, and installing the pipe, and for all materials, equipment, tools, labor, and incidentals necessary to complete the item, but shall not constitute payment for excavation or headwalls.

SECTION 37.

CORRUGATED GALVANIZED METAL PIPE CULVERTS.

37.1 Description. Under this item corrugated metal culvert pipe, conforming to these specifications, of the sizes and dimensions shown on the plans shall be furnished and placed as directed.

37.2 Material. Corrugated metal culvert pipe shall be fabricated from corrugated sheets, the base metal of which shall be made by the open hearth process. The base metal in the finished sheets shall conform to the following chemical requirements:

Elements	Chemical Composition by Ladle Analysis Position of Base Metals Does Not Indicate Preference.					Tolerance by Check Analysis of Finished Sheets
	Pure Iron	Copper Bearing Pure Iron	Copper Iron	Copper Molybdenum Iron	Copper Steel	
Carbon Maximum per cent	—	—	—	—	—	—
Manganese Maximum per cent	—	—	—	—	—	—
Phosphorous Maximum per cent	.015	.015	.015	.015	—	—
Sulphur Maximum per cent	.040	.040	.040	.040	.050	.010
Silicon Maximum per cent	—	—	—	—	—	—
Copper Minimum per cent	—	.20	.20	.40	.20	.02
Molybdenum Minimum per cent	—	—	—	.05	—	—
Sum of First Five Elements Maximum per cent	—	.10	.25	.25	.70	.04
Sum of First Six Elements Maximum per cent	.10	—	—	—	—	.04

Rivets. All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

Gauge Determination and Tolerance. The gauge of culvert sheets shall be determined by weight only. The gauge weight tolerances shall be those given in Table III of the Standard Specifications for Zinc-coated (Galvanized) Sheets, Serial Designation A 93-27, of the American Society for Testing Materials and subsequent revisions. The portion of this table which applies to the sheets provided for in this specification is as follows:

Gauge range	Permissible tolerances in weights of sheets, plus or minus, in percentage of theoretical weight[1]			Gauge range
Weight of sheets, oz. per sq. ft. Not less than	All of one gauge and size in shipment[2]	Single packages	Single sheets	Galvanized sheet gauge number Not lighter than
42.5	5.0	7.0	10.0	16

[1] References are to gross weights of bundled material and to net weights of crated and boxed material. If the minimum or maximum only be ordered, double tolerance is to be taken on permissible side.
[2] All of one gauge and size in shipment shall apply to lots of not less than 6,000 pounds.

Spelter Coating. The base metal sheets shall be uniformly galvanized on both sides by the hot process. A uniform coating of Prime Western spelter shall be applied at the rate of not less than 2 ounces per square foot of metal. If the average spelter coating as determined from samples shows less than 2 ounces of spelter per square foot of metal, or if any one sample shows less than 1.8 ounces of spelter per square foot of metal, the shipment shall be rejected. Sheets having blister spots, holes, or other imperfections in the galvanizing after corrugating shall be rejected.

The tests for weight of spelter coating shall be made as described in the Tentative Method T-65 of the American Association of State Highway Officials.

Accepted Brands. No metal will be accepted under these specifications and no bids will be considered for the materials above described until after the sheet manufacturer's certified analysis and manufacturer's guarantee have been passed upon by the Engineer and accepted.

Misbranding or other misrepresentation and nonuniformity of product will each be considered a sufficient reason to discontinue the acceptance of any brand under these specifications, and the notice of discontinuance of any brand sent to the sheet manufacturer will be considered to be notice to any culvert companies which handle that particular brand.

Certified Analysis. The manufacturer of each brand shall file with the Engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of

each of the seven above mentioned chemical elements. The certificate shall be sworn to for the manufacturing company by a person having legal authority to bind the company.

Manufacturer's Guarantee. The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, shall bear a suitable identification brand or mark, and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge, or spelter coating; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

Identification. No culverts will be accepted unless the metal is identified by a stamp on each section showing: First, name of sheet manufacturer; second, name of brand; third, the gauge.

The identification brands shall be placed on the sheets by the manufacturers of the sheets, in such a way that when rolled into culverts such identification shall appear on the outside of each section of each pipe. Pipe having any sections not so stamped shall be promptly rejected.

Tests. Laboratory tests shall follow the tentative method of sampling and testing as adopted by the American Association of State Highway Officials. The analysis made by the chemists or inspection bureau designated or approved by the Engineer shall be taken as final, but before any considerable shipment is rejected a check analysis shall be made.

If the Engineer so elects, he may have the material inspected at the rolling mill or the culverts inspected in the shop where they are fabricated. He may require a chemical analysis from the mill for any heat, also a physical test of the properties of the metal taken from any heat, to be made by the mill. The inspection both at the mill and at the shop shall be made under the direction of the Engineer. The Engineer, or his representative, shall have free access to the mill or shop for inspection purposes and every facility shall be extended to him for this purpose. Any material or pipe included in any shipment which has been rejected at the mill or shop will be considered sufficient cause for the rejection of the entire shipment.

37.3 Construction of Pipe. Pipe furnished under these specifications shall be of the full circle riveted type, with lap-joint construction.

Net Length. The length of culvert specified shall be the net length of the finished culvert which does not include any material used to procure an end finish on the pipe. If the average deficiency in length of any shipment of pipe is greater than 1 per cent, the shipment shall be rejected.

Length of Sections. All pipe shall be furnished in the lengths ordered, except that pipe for culverts 26 feet or more in length may be furnished in sections not less than 12 feet in length, provided all necessary field couplings are furnished free of charge. For small shipments involving less than carload lots, the above requirements may be modified by written authority from the Engineer.

Dimensions and Weights. The length of sheets, widths of laps, gauge of the uncoated metal (United States standard gauge), and theoretical weight per lineal foot of the finished culvert shall be as specified in the following table. The dimensions given for diameter of pipe are nominal. The average weight per lineal foot of a finished culvert, exclusive of end fittings, shall not underrun the theoretical weight specified by more than 5 per cent.

Nominal diameter	Length of sheet before forming	Width of lap	Minimum gauge United States standard	Weight per lineal foot of finished culvert	Minimum gauge connecting bands
Inches	Inches	Inches	-	Pounds	
12	41	1.5	16	10.5	16
15	50.5	1.5	16	12.9	16
18	60	1.5	16	15.2	16
24	80	2.0	14	25.2	16
30	98	2.0	14	30.9	16
36	117	2.0	12	51.0	14
42*	137	2.0	12	59.5	14
48*	156	3.0	12	68.0	14
60	98 (2)	3.0 (2)	10	108.9	12
72	117 (2)	3.0 (2)	10	130.4	12
84	137 (2)	3.0 (2)	8	185.2	12

* Two sheets may be used by allowing sufficient total sheet lengths to provide for an additional standard lap.

Corrugations. Corrugations shall be not less than 2¼ nor more than 2¾ inches center to center. The corrugations shall have a depth of not less than one-half inch.

Rivets. Rivets shall have the following dimensions:

No. 16 gauge material	(two thicknesses of sheets),	5/16	by	1/2	inch.
No. 16 gauge material	(three thicknesses of sheets),	5/16	by	5/8	inch.
No. 14 gauge material	(two thicknesses of sheets),	5/16	by	5/8	inch.
No. 14 gauge material	(three thicknesses of sheets),	5/16	by	3/4	inch.
No. 12 gauge material	(two thicknesses of sheets),	3/8	by	3/4	inch.
No. 12 gauge material	(three thicknesses of sheets),	3/8	by	7/8	inch.
No. 10 gauge material	(two thicknesses of sheets),	3/8	by	3/4	inch.
No. 10 gauge material	(three thicknesses of sheets),	3/8	by	7/8	inch.
No. 8 gauge material	(two thicknesses of sheets),	3/8	by	7/8	inch.
No. 8 gauge material	(three thicknesses of sheets),	3/8	by	1 1/8	inch.

All rivets shall be driven cold in such a manner that the plates shall be drawn tightly together throughout the entire lap. No rivet shall be closer than twice its diameter from the edge of the metal. All rivets shall have neat, workmanlike, and full hemispherical heads, or heads of a form acceptable to the Engineer; shall be driven without bending; and must completely fill the hole. Longitudinal seams shall be riveted with one rivet in each full corrugation. The longitudinal seams of 42-inch pipe and larger shall be double riveted.

Circumferential shop riveted seams shall have a maximum rivet spacing of six inches, except that six rivets will be sufficient in 12-inch pipe.

End Finish. If headwalls are not to be constructed, the inlet and outlet ends of all culverts fabricated of 16 or 14 gauge sheets shall be reinforced with rolled ends in a manner approved by the Engineer.

Coupling Bands. Field joints shall be made with bands of the same base metal as the culverts, and shall be not less than 7 inches wide for pipes 30 inches and less in diameter, 12 inches for pipes 36 inch to 48 inches in diameter, and 24 inches for pipes 60 inches to 84 inches in diameter, so constructed as to lap an equal portion of each of the culvert sections to be connected. Such bands shall be connected at the ends by angles having minimum dimensions of 2 x 2 x 3/16 inch, and of length equal to full width of band, or by other approved connections of suitable strength. Each connection shall be fastened by at least two bolts not less than ½ inch in diameter for 7-inch bands, by three bolts for 12-inch bands, and by five bolts for 24-inch bands. All angle irons and bolts shall be hot dipped or electro galvanized.

Workmanship. It is the essence of these specifications that in addition to compliance with the details of construction the completed pipe shall show careful, finished workmanship in all particulars.

Culvert pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which show defective workmanship, shall be rejected. This requirement applies not only to the individual pipe but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and in the presence of any or all of them in any individual culvert pipe or in general in any shipment shall constitute sufficient cause for rejection: Uneven laps; elliptical shaping; variation from a straight center line; ragged or diagonal sheared edges; loose, unevenly lined or spaced rivets; poorly formed rivet heads; unfinished ends; illegible brands; lack of rigidity; bruised, scaled, or broken spelter coating; dents or bends in the metal itself.

Field Inspection and Acceptance. The field inspection shall be made by the Engineer, who shall be furnished by the Contractor with an itemized statement of the sizes and lengths of culvert pipe in each shipment. This inspection shall include an examination of the culvert pipe for deficiencies in length of sheets used, nominal specified diameter, net length of finished culvert pipe, and any evidence of poor workmanship as outlined above. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating. The inspection shall be made promptly upon notification by the Contractor of the arrival of the material.

The pipe making up the shipment shall fully meet the requirements of these specifications, and if 25 per cent of the pipe in any shipment fails to meet these requirements the entire shipment may be rejected.

When samples are taken for chemical analysis and determination of weight of spelter coating, at least one sample from which a specimen 2¼ inches may be prepared shall be selected from each 10 culverts of a shipment, and not less than three samples shall represent any one shipment.

37.4 Construction Methods. Culverts under the highway shall be placed so that the minimum distance from finished grade of roadway to the top of the pipe shall be not less than one-half the diameter of the pipe with a minimum of one foot.

A trench shall be excavated to the depth and grade established by the Engineer. The bottom of the trench shall be shaped to conform to the bottom of the pipe and to afford a firm and uniform bearing throughout the entire length of the culvert. If, in the opinion of the Engineer, the material in the bottom of the excavation is of such a character as to cause unequal settlement along the length of the culvert, the trench shall be dug below the grade given, to such a depth as ordered, and backfilled with gravel or other suitable material and thoroughly tamped or otherwise compacted to insure an unyielding foundation. Where the trench is in solid rock or other hard material, it shall be excavated to a depth of at least 4 inches below the grade established for the bottom of the pipe, and this additional excavation shall be backfilled with suitable material in such manner as to insure a uniform bearing for the entire length of the culvert.

The pipe shall be laid in the trench with the separate sections firmly joined together and with outside laps of circumferential joints pointing up stream and with longitudinal laps on the sides. Any metal in joints which is not thoroughly protected by galvanizing shall be coated with a suitable asphaltum paint.

Selected backfilling material, free from stones, frozen lumps, etc., shall be placed under and around the pipe and thoroughly tamped or otherwise compacted in place. The trench shall be completely filled and the pipe covered to a depth of at least one foot with hand placed and properly compacted materials before the construction of embankment over the culvert shall proceed in the usual manner.

If trenching is not required, the culvert pipe shall be laid, true to line and grade, on a bed that is uniformly firm throughout its entire length, and the backfilling around and over the pipe shall be completed as specified in the preceding paragraph.

The pipe shall be so shipped and handled as to prevent bruising, scaling, or breaking the spelter coating. In no case shall pipes be dragged on the ground.

The vertical diameter of all pipe 48 inches in diameter under fills of 25 feet or more and all culverts of more than 48 inches diameter shall be elongated approximately five per cent (5%) before the backfill is made. The compression sills used in this deflection of the pipe shall be of wood and shall extend the full length of the pipe. The bottom sill shall consist of one row of not less than 6″ x 6″ timber and the top sill shall consist of two rows of not less than 6″ x 6″ timbers placed side by side. Each timber in a sill shall be not less than 10 feet in length. The vertical struts shall be not less than 6″ x 6″ timbers and of the proper length to give a uniform deflection of the pipe to the specified elongated diameter. Vertical struts shall be placed not more than six feet apart. Caps between the upper sill and vertical struts shall be not less than 6″ x 6″ x 12″ in size. Struts shall be left in place for at least one month after completion of the embankment.

37.5 Method of Measurement and Basis of Payment. This item shall be paid for at the contract unit prices bid per foot of corrugated metal pipe culvert of the several sizes, measured complete in place, which price shall be full compensation for furnishing, hauling, and installing the pipe, for preparation of the bed and backfilling, and for all material, equipment, tools, labor, and incidentals, but shall not be payment for excavation nor for concrete or masonry end walls.

Should it be determined on construction that the length of any culvert as called for on the plans is insufficent, then the Contractor shall provide and place the necessary additional length required at the contract unit prices bid per foot for the appropriate size, but the furnishing and placing of additional connecting bands necessitated because of such change in the culvert lengths, shall be paid for as extra work in accordance with the provisions of Article 9.4 of these specifications.

SECTION 38.

SPECIFICATIONS FOR RELAYING PIPE CULVERT.

38.1 Description. This item shall consist of the careful removing, cleaning and preserving of pipe from existing pipe culverts and relaying the same as shown on the plans or as designated by the Engineer.

38.2 Construction Methods. The construction methods shall conform to those required in the specifications for the various kinds of pipe laid as hereinbefore specified in Sections 36 and 37.

38.3 Method of Measurement. This item shall be measured by the actual number of lineal feet of pipe relaid as directed, complete in place.

38.4 Basis of Payment. Relaid culvert pipe, measured as provided above, shall be paid for at the contract unit prices per lineal foot bid for "Relaying Pipe Culvert," of the various types but irrespective of size, which prices shall be full compensation for the removal, cleaning, preservation, hauling and relaying the pipe, and for all new materials required except pipe, and for all labor, equipment, tools and incidentals necessary to complete the work; except that excavation and backfilling for the removal and relaying of the pipe shall be measured and paid for as "Structure Excavation" and new concrete or masonry headwalls, if required, shall be paid for as a separate item or items.

SECTION 39.

PIPE SYPHONS.

39.1 Description. Under this item, syphon pipe of galvanized corrugated metal of the sizes and dimensions shown on the plans shall be furnished and placed as directed.

39.2 Material. The pipe used shall conform to the specifications for corrugated galvanized metal pipe as hereinbefore contained in Section 37. In addition, the seams and joints shall be close riveted and soldered water tight. Where field connections are necessary, they shall be made water tight by the addition of a concrete collar composed of Class"D" concrete or approved 1 :3 cement mortar cast around the joint. This collar shall be at least six inches thick and shall extend at least one foot on each side of the joint. Field connections will not be allowed within thirteen (13) feet of the centerline of the road.

39.3 Construction Methods. Pipe syphons shall be laid in accordance with the methods described in Section 37.4 for galvanized corrugated metal pipe culverts.

39.4 Method of Measurement and Basis of Payment. This item shall be paid for at the contract unit price bid per lineal foot of syphon pipe of the several sizes, measured complete in place, which price shall be full compensation for furnishing, hauling, and installing the pipe, for the preparation of the bed and backfilling, and for all material, equipment, tools, labor, and incidentals, but shall not be payment for excavation nor for concrete or masonry end walls.

SECTION 40.

CEMENT RUBBLE MASONRY.

40.1 Description. Cement rubble masonry shall be composed of approved stones laid in mortar beds and shall be constructed in conformity with the plans or as directed in writing by the Engineer.

40.2 Material. The Portland cement, sand, and water for the mortar shall be such as to conform with the respective requirements for these materials as contained in the specifications hereinbefore given for concrete.

The stone for rubble masonry shall be clean, hard, and of a kind known to be durable. All weathered stone shall be rejected. The individual stones, except for filling joints, shall have a thickness of not less than 5 inches and a width of not less than one and one-half times the thickness nor less than 12 inches. No stone, except headers, shall have a length less than one and one-half times its width.

40.3 Construction Methods. All rubble masonry shall be constructed by experienced workmen. Selected stones, roughly squared and pitched to lines, shall be used at all angles and ends of walls. All stones shall be thoroughly wet prior to laying and be laid with practically horizontal beds, large flat stones shall be selected for the bottom courses. All stones shall be fully bedded in Portland cement mortar mixed in the proportion of 1 part cement to three parts of sand and shall be so placed as to break joints at least 6 inches and form a firm bond. Mortar which is not used within 30 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted.

For mortar the sand and cement shall first be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains a consistency such that it can be easily handled and spread with a trowel.

Headers shall be distributed uniformly through the walls of the structure so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend through the face wall into

the backing at least 12 inches, and where a wall is less than 18 inches in thickness the headers shall extend entirely through from front to back face.

The interior of the walls shall be built up so that the stones of which it is composed will be bonded, and so that no open spaces will be left. Horizontal joints in the face shall not exceed 1 inch in thickness and vertical joints shall not exceed 2 inches in width. No spalls shall be used in the face of a wall, and the face stones shall be so well bedded that none will be needed. Walls shall be provided with weep holes wherever called for on the plans or directed by the Engineer. If a stone is loosened after the mortar has set it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

This class of masonry shall be finished with a concrete coping or with a top course consisting of roughly shaped stones. Copings, bridge seats, and back walls, unless otherwise specified, shall be of class A concrete, which shall be not less than 8 inches thick and wide enough to cover the full width of the wall and shall be cast in place. If a stone coping is specified, the stones shall be not less than 8 inches thick, from 1½ to 4 feet long and wide enough to cover the top of the wall, set in full mortar beds as shown on the plans.

After the stone is all laid as above specified the face joints shall be thoroughly cleaned of all mortar to a depth of 1 inch. The joints shall then be wetted and pointed with Portland cement mortar, mixed in the proportion of 1 part of cement to 1 part of sand. No pointing shall be done in freezing weather, and any work damaged by frost shall be removed and replaced. In hot or dry weather the pointed masonry shall be satisfactorily protected from the sun and kept wet for a period of three days after completion.

No masonry shall be laid in freezing weather without the permission of the Engineer and the use of such precautions as he may direct to be taken. In hot or dry weather the masonry shall be protected from the sun for at least three days after laying.

40.4 Basis of Payment. This work shall be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the Engineer, and will be paid for at the unit price bid per cubic yard for cement rubble masonry complete in place, which price will be full compensation for the concrete coping or stone top course, whichever is required, and for all materials, equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 41.

DRY RUBBLE MASONRY.

41.1 Description. Dry rubble masonry shall be composed of approved stones laid without mortar and so as to fit neatly and firmly, and shall be built in conformity with the plans or as directed by the Engineer.

41.2 Material. The stones shall be sound, durable, free from structural defects, and shall be free from rounded, worn, or weathered surfaces, and clean of earth, clay, or other foreign substances. No stone shall be used which has a minimum thickness of less than 5 inches, a minimum width of less than 12 inches, or which is less than ½ cubic foot in volume. In the lower course of a dry rubble wall no stone shall be used which has a volume of less than 1 cubic foot. Small stones may be used for pinning and filling interstices in the heart of the wall.

41.3 Method of Construction. All dry rubble masonry shall be constructed by experienced workmen. The stone shall be roughly dressed on beds and joints and laid on natural beds, being well bonded and breaking joints at least 6 inches. Walls need not be built in courses, but shall be so constructed that no part is materially in advance of the other. In all cases the base thickness of dry walls shall be at least half the height, which shall not exceed 8 feet. Headers shall be distributed uniformly throughout the wall, so as to form approximately one-fifth of the exposed faces, and shall extend through the face wall and into the backing at least 12 inches. Where a wall is less than 18 inches in thickness, the headers shall extend entirely through from front to back face. Where the wall is more than 18 inches thick, the headers shall either extend entirely through or overlap at least 6 inches. Walls shall be built up so as to leave no appreciable open spaces, and only sufficient spalls shall be used to wedge the larger stones in place. This class of masonry shall be finished with a top course or coping consisting of roughly shaped stones not less than 6 inches thick, from 1½ to 4 feet long, and wide enough to cover the top of the wall, carefully laid in solid beds.

41.4 Basis of Payment. This work will be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the Engineer, and will be paid for at the unit price bid per cubic yard for dry rubble masonry complete in place which price will be full compensation for the coping and all materials, equipment, tools, labor and incidentals necessary to complete the item.

SECTION 42.

LOG BRIDGES AND TRESTLES.

42.1 Description. All log trusses and log trestles shall be built as indicated on the plans conforming in all respects to the line, grade, and dimensions shown and in accordance with these specifications.

42.2 Material. The logs used in constructing log bridges shall be of the species specified on the plans, or if not therein specified, as required by the Engineer. The logs may be obtained and the tops and branches of trees shall be disposed of as provided in the specifications for clearing and grubbing, as hereinbefore given.

The logs shall be straight, sound, out of wind, and free from defects of all kinds and shall be cut from live trees not less than 30 days in advance of use, but not exceeding 1 year, and be allowed to season with bark on. Immediately before use in the work all bark shall be peeled and the logs trimmed smooth of all knots and projections.

Steel truss rods, structural shapes and plates, steel and iron castings shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given.

All lumber for flooring, railing, etc., shall be of the kind and dimensions indicated on the plans and shall be free from shakes, wanes, black and unsound knots, and from all other defects which would impair its strength in any way.

The contractor shall furnish all necessary bolts, driftbolts, spikes, nails, and other material or hardware called for on the plans or in the specifications.

42.3 Construction Methods. The Contractor shall provide experienced workmen and ample and suitable equipment and tools for performing the work and shall follow only well-recognized methods in preparing the timber and framing and erecting the structure. Where concrete or masonry piers or abutments are called for on the plans, they shall be constructed in accordance with the requirements of the plans and of the specifications herein given for the particular kind of excavation, concrete or masonry called for, and be paid for as thereunder prescribed.

The provisions for preservative treatment, bridge iron and methods of construction as specified for timber structures, shall apply to log bridges and trestles.

42.4 Basis of Payment. Each log truss and log trestle span complete will be paid for at the price bid per span complete, as shown on the plans, which shall include all parts of the bridge except abutments, piers, and timber bents. This price shall be full compensation for all materials, necessary hardware, equipment, tools, labor, painting, preservative treatment and all incidentals necessary to complete the structure ready for use; provided, however, that supplementary floor wearing tops shown on the plans will be paid for as provided in the special provisions attached hereto.

Log timberbents, including sills, caps, columns, posts, and bracing, will be paid for at the contract unit price bid per lineal foot of log, as shown on the plans. This price shall be full compensation for all materials, hardware, preservative treatment, equipment, tools, labor, and incidentals required to construct and complete the bents in accordance with the plans and specifications.

SECTION 43.

LOG ABUTMENTS FOR BRIDGES.

Log abutments for bridges will be built according to the specifications for log cribbing, and as shown on the plans, and will be paid for as log cribbing.

SECTION 44.

LOG CRIBBING.

44.1 Description. All log cribbing shall be built as indicated on the plans, conforming in all respects to the line, grade, and dimensions shown, and in accordance with these specifications.

44.2 Material. The Contractor shall secure and prepare all necessary logs, timber, hardware, etc., under the conditions and as called for under the heading "material for log bridges."

44.3 Construction Methods. The cribbing shall be supported on mudsills, with flattened lower surfaces placed as shown on the plans. All logs, including face logs, tie logs, mudsills, and anchor logs, shall be properly notched together and driftbolted, as shown on the plans. The ends of the logs and all cut surfaces shall be treated with preservative as hereinbefore specified for timber structures.

The minimum lengths and sizes of logs shall be as shown on the plans. Each course of logs shall break joint with the adjacent courses. The lengths of tie logs required for the proper support and anchorage of the cribbing shall be as determined by the Engineer.

The face and tie logs are to be so notched together, and hewn if necessary, that the face logs will be in contact with each other throughout their entire length, except that in case a satisfactory rock backing is placed against the face logs, the Engineer may permit open spaces not exceeding 4 inches in width between the face logs. When permission to use such spaces is given, the rock back fill shall be carefully placed, using the larger rocks adjacent to the logs and backing up with the smaller rocks in such manner that earth and finer materials may not escape or be washed out.

44.4 Basis of Payment. Payment will be made at the unit price bid per square foot of crib face in place complete, which shall include the furnishing and placing of transverse mudsills, tie logs, anchor logs, and driftbolts. Such unit bid price shall be full compensation for all materials, hardware, equipment, tools, labor, and incidentals for the construction of the cribbing complete.

SECTION 45.

LOG CULVERTS.

45.1 Description. All log culverts shall be built as indicated on the plans, conforming in all respects with the line, grade, and dimensions shown, and in accordance with these specifications.

45.2 Materials and Methods of Construction shall be as prescribed for "log bridges" and "log cribbing."

45.3 Method of Measurement. Log culverts shall be measured along the center line, and over-all length shall be taken.

45.4 Basis of Payment. Log culverts shall be paid for at the contract unit price bid per lineal foot of log culvert of the respective sizes as set forth in the proposal, which price shall be full payment for all material, equipment, tools, labor, and incidentals necessary to complete the work.

STATE OF MONTANA

State Highway Commission

Standard Specifications
for
Highway Construction

DIVISION 2—CONSTRUCTION DETAILS
PART 4—INCIDENTAL CONSTRUCTION

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HELENA, MONTANA

SECTION 46.
RIPRAP.

46.1 Description. Where necessary, slopes shall be protected by riprap, which shall be constructed at the places indicated, and of the shape and thickess shown on the plans or directed by the Engineer.

46.2 Material. The stone for this work shall be sound, durable, one-man stone, not less than 3 inches thick nor containing less than one-half of a cubic foot in volume. For hand-laid riprap, no stone shall be used that does not extend through the revetment.

46.3 Method of Construction. (a) Handlaid riprap. The slopes protected shall not be steeper than the angle of repose of the material unless otherwise indicated. The stones shall be placed with their beds at right angles to the slope, the larger stones being used in the bottom courses and the smaller stones at the top. They shall be laid in close contact so as to break joints, and in such manner that the weight of the stone is carried by the earth and not by the adjacent stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The finished work shall present an even, tight, and reasonably plain surface, varying not more than 3 inches from the required contour.

(b) Random riprap, graded so that the smaller stone is uniformly distributed throughout the mass, shall be dumped promiscuously over the area until the required depth is attained.

46.4 Basis of Payment. This work will be paid for at the unit price bid per cubic yard for hand-laid riprap or random riprap, as the case may be, complete in place, which price will include all necessary excavation, back filling, materials, equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 47.
HAND-LAID ROCK EMBANKMENT.

47.1 Description. When necessary, slopes shall be steepened on embankments and the embankments strengthened by the use of hand-laid rock which shall be constructed according to the lines and dimensions given by the Engineer before work is started.

47.2 Material. The stone for this work shall be sound and durable, not less than one-half cubic foot in volume, and may be taken from the adjacent excavation.

47.3 Method of Construction. An adequate footing shall first be excavated in stable ground along the toe of the slope of the proposed fill. The selected stone material shall be placed by hand on this prepared footing and additional stone laid up to the width and dimensions directed. Care shall be taken to have the stones bonded to some extent and securely bedded. Spalls shall be used to fill voids. The hand-laid rock embankment thus constructed shall be backed by the usual embankment placed as prescribed under earthwork.

47.4 Method of Measurement. Hand-laid rock embankment shall be measured when complete in place as ordered. The excavation for the footing prescribed shall not be measured.

When stone material for this item is obtained from roadway or other prescribed excavation, no deduction from the excavation yardage for the stone so used shall be made.

47.5 Basis of Payment. This item shall be paid for at the unit price bid per cubic yard for hand-laid rock embankment complete in place, which price shall be full payment for selecting and placing by hand the material measured, and for all footing excavation, equipment, tools, labor, and incidentals necessary to complete the item.

SECTION 48.

UNDERDRAINS.

48.1 Description. At such places as are shown on the plans or as are designated by the Engineer, underdrains shall be constructed. They shall have suitable outlets in culverts or such other outlets as to drain water entirely away from the road and protect the outlet of the drain. They shall be constructed directly under the gutter or ditch or under the roadway to the line and grade furnished by the Engineer and in accordance with the plans and these specifications.

48.2 Material and Method of Construction. (a) *Vitrified Tile Underdrain.* The trench shall be excavated with a bottom width of 12 inches to the line and grade given by the Engineer, the depth of trench to vary from 2½ to 3½ feet below the finished surface at the top of the trench. A 2-inch bed of clean gravel or broken stone, all passing a 1-inch screen, shall be spread in the bottom of the trench throughout its entire length and brought to a uniform grade. Salt-glazed, bell and spigot, vitrified drainpipe of the size specified shall be bedded firmly in the bottom course of stone, with the bell end upgrade and the spigot end fully entered in the adjacent bell. The pipe joints shall then be covered with 2-ply tarpaper strips not less than 6 inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of stone on either side of the pipe for a distance of 3 inches. The pipe used shall conform to the standard specifications of the American Society for Testing Materials for clay sewer pipe, Serial Designation C13-33T.

After the pipe has been laid and approved by the Engineer, clean gravel or broken stone filling, all passing a 3½-inch screen and retained on a ¾-inch screen, shall be placed carefully so as not to displace the pipe or joint covering, around and over the pipe to a depth of at least 12 inches above the top of the pipe. The remainder of the trench shall be filled with selected earth material from excavation. Both stone and surface filling shall be firmly tamped.

(b) *Porous Tile Underdrain.* Porous tile underdrain shall be laid in the same manner as specified for vitrified tile underdrain. The tile shall conform to the requirements of the American Society for Testing Materials Standard Specifications for Drain Tile, Serial Designation C4-24.

(c) *Blind Drain.* Where blind drains are called for, they shall be dug to the cross section shown on the plans and from 30 to 40 inches in depth, depending on the nature and conditions of the soil to be drained. The trench thus prepared shall be filled with clean, broken stone or gravel, from 1 to 3½ inches in size, well compacted to within 12 inches of the gutter surface. The upper 12 inches of the trench shall then be filled with suitable earth material. Both stone and surface filling shall be firmly tamped to avoid future settlement.

(d) *Drains at Weep Holes.* Drains at weep holes in bridge abutments, wing walls, and retaining walls shall be constructed as indicated on the plans or directed by the Engineer. The material used for the drain shall consist of clean broken stone or gravel not less than one (1) inch nor more than three and one-half (3½) inches in size. The stone or gravel shall be thoroughly tamped after being placed.

48.3 Method of Measurement and Basis of Payment. (a) Vitrified tile underdrain, porous tile underdrain, and blind shall be measured by the lineal foot and shall be paid for at the unit price bid per lineal foot for the item.

(b) Gravel or broken stone for drains at weep holes shall be measured by the cubic yard loose measurement in the vehicle at the point of delivery and shall be paid for at the unit price bid per cubic yard for the item.

(c) Excavation work and backfill will be measured and paid for as "Structure Excavation" in accordance with the provisions as hereinbefore contained in Articles 12.4 and 12.5.

The unit price bid for underdrains of the several classes shall be for the items complete in place including the furnishing of all materials, equipment, tools, and labor and the performance of all work necessary or incidental to the proper completion of the item, or items.

SECTION 49

METAL DITCH LINING AND FLUME

49.1 Description. This item shall be for the protection of such irrigation systems as must be adjusted because of interference with the highway construction work, and shall include the construction

of flumes where necessary and the construction of semi-circular galvanized metal ditch lining for ditches through easily washed or porous soils.

49.2 Materials. (a) Metal flume and ditch lining shall be made of 20 gauge (U. S. Standard) galvanized ferrous sheets and shall be of semi-circular smooth interior type. The base metal and spelter coating shall comply with the physical and chemical requirements as specified hereinbefore for culvert pipe in Section 37. The completed flume or ditch lining shall consist of formed and beaded sheets, carrier rods, compression bars, shoes, anchor rods, nuts, and washers, all of which shall be galvanized. The joints between successive sheets comprising the lining shall be designed to provide rigidity and water tightness, and they shall offer the least possible resistance to flow. Carrier rods, compression and anchor bars, shoes, nuts, washers and hanger plates shall have a galvanized coating of not less than ¾-ounce of commercially pure zinc per square foot of surface. The coating shall be capable of withstanding three immersions for a period of one minute each in a standard testing solution of copper sulphate without showing any trace of metallic copper on the steel.

(b) The lumber used shall be No. 1 common, graded according to the Standard Grading and Dressing Rules No. 9, of the West Coast Lumbermen's Association, dated July 1, 1934, or equivalent grades of other regional associations of lumber manufacturers which conform to the basic provisions of the "American Lumber Standards" as adopted by the U. S. Department of Commerce. The use of the following listed species of wood will be allowed: Douglas Fir, West Coast Hemlock, Western Red Cedar and Ponderosa Pine.

49.3 Construction Methods. The framing, erection, and completion of the timber portions of the structure shall be done in conformity with the appropriate provisions for "Timber Structures" as hereinbefore specified in Article 34.5 and in accordance with the detail plans.

The metal ditch lining and metal flume shall be laid true to line and grade, on a bed that is uniformly firm throughout its entire length. The separate sections shall be firmly joined together with the outside laps of circumferential joints pointing upstream.

49.4 Methods of Measurement and Basis of Payment. (a) Lumber in flumes shall be measured and paid for as hereinbefore provided for in Articles 34.8 and 34.9.

(b) Metal flume shall be measure by the lineal foot of metal flume complete in place and shall be paid for at the unit contract price bid for this item, which price shall be payment in full for all materials (including all fittings such as carrier rods, compression and anchor bars, shoes, nuts, washers, etc.), tools, labor and equipment and for the performance of all work necessary or incidental to the proper completion of the item.

(c) Metal ditch lining shall be measured by the lineal foot of ditch lining complete in place and shall be paid for at the unit contract price bid for this item, which price shall be payment in full for furnishing, hauling and installing the lining; for preparation of the bed and backfilling; for excavating, installing and backfilling for anchor rods and dead men; and for all materials (including wood carrier beams, anchor rods, dead men, shoes, nuts, bolts, stringers, etc.), equipment, tools, labor and incidentals necessary to complete the work.

SECTION 50.

SPECIFICATIONS FOR WOOD SLAT SNOW FENCE.

50.1 Description. This item shall consist of the erection of snow fence, in accordance with the standard design for woven wire wood slat snow fence, at the locations shown on the plans or where directed by the Engineer.

50.2 Material. *Snow Fence.* Slat snow fencing shall consist of one-half (½) inch by one and one-half (1½) inch by four (4) feet wooden slats woven together with five (5) cables, each cables consisting of two (2) galvanized wires not smaller than twelve and one-half (12½) (American Steel and Wire) gauge. The slats shall be spaced two (2) inches apart. Each wire cable shall have two (2) complete turns in the weave in each space between the slats, and at the outside end of each roll there shall be left one (1) foot of untwisted cable (two (2) wires)—from which samples may be taken for testing.

The fence shall be put up in rolls of from fifty (50) to one hundred (100) feet as ordered. Fabric is to be tightly woven and wires forced into slats in such a manner as to hold them tightly. Fence shall be stretched after weaving and before being placed in rolls.

All wire shall be basic open hearth galvanized steel. The average diameter of the uncoated or stripped wire shall be .0985″ ± 0.003″. The wire shall show no sign of fracture and no flaking of the spelter when wound about a No. 1 mandrel two turns at the rate of 15 turns per minute. Fabrication shall be done so as to not damage spelter coating or impair the tensile strength of the wire. The wire shall carry a minimum of 0.6 ounces spelter coating per square foot and shall be capable of withstanding three (3) one minute and one (1) one-half (½) minute immersions in a standard solution of copper sulphate without showing any trace of metallic copper on the steel. Tests shall be run according to tentative methods adopted by the American Association of State Highway Officials under designations T-65 Section (b) and T-66 with subsequent revisions.

All slats shall be made from good sound merchantable wood except that basswood, poplar or cottonwood will not be permitted. The slats shall be No. 1 grade conforming to the grading for No. 1 dry lath as specified for Douglas Fir in the West Coast Lumbermen's Association Standard Grading and Dressing Rules, Number Ten, dated July 1, 1934. They shall be given a waterproofing and preservative treatment by being immersed in Grade 1 hot creosote oil or a hot solution of red oxide of iron as approved by the Engineer.

Posts used in the construction of woven wire wood slat snow fence shall be seven feet long and furnished without anchor. Posts shall be given at least one coat of approved paint. The section form of posts may be tubular, tee, equal angle, tee-rail or modified channel provided that all posts weigh at least 1.33 pounds per lineal foot.

50.3 Method of Construction. The snow fence shall be erected at locations shown on the plans or specified by the Engineer. The posts shall be driven into the ground to the depth indicated on the standard plan and the wood slat fencing material shall be tightly stretched and securely wired to the posts. End posts shall be guyed in three directions and intermediate posts shall be guyed as indicated on the plans or as directed by the Engineer.

50.4 Method of Measurement. Wood Slat Snow Fence shall be measured by the lineal foot from outside to outside of end posts.

50.5 Basis of Payment. This work shall be paid for at the contract unit price per lineal foot for "Wood Slat Snow Fence" measured complete in place from outside to outside of end posts, which price shall be payment in full for the furnishing of all materials, equipment, tools and labor and for the performance of all work necessary or incidental to the proper completion of the item.

SECTION 51.

WOOD GUARD RAIL AND GUIDE POSTS.

51.1 Description. Multiple or single-rail guard rail or guide posts of either rustic, rough-sawed, or surfaced and painted timber shall be constructed where called for on the plans or directed by the Engineer, and shall conform in all respects to the requirements of the plans or the special provisions.

51.2 Material. The posts and railing shall be of the species of timber specified on the plans or, if not specified thereon, as required by the Engineer.

Round or rustic posts shall be straight, sound, and free from defects of all kinds, and shall be cut from live trees not less than 30 days in advance of use, but not exceeding one year. All bark shall be peeled and the logs trimmed smooth of all knots and projections.

Sawed posts and rails shall be equal to the grade defined as select common in accordance with American Lumber Standards for soft wood lumber. Sawed railing shall be of sufficient length to span two panels, except on curves. When surfaced lumber is called for on the plans, it shall be surfaced four sides, and the dimensions indicated shall be construed to mean the nearest commercial size.

Paint used in painting wood guard rail shall conform to the specifications for paints for woods as hereinafter set forth in Section 53.

All metal fittings shall be galvanized by the Hot Dip Method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to the surface. It shall be capable of withstanding four (4) immersions in a standard testing solution of copper sulphate without showing any trace of metallic copper on the steel. The first three (3) immersions shall be for a period of one minute each and the fourth (4th) immersion for a period of one-half minute.

51.3 Method of Construction. Posts shall first be painted with three coats of approved black paint at their butt or lower ends as shown on the plans to a point 8 inches above the ground line. The posts shall be set vertically to the depth shown on the plans. They shall be maintained in accurate alignment while the post holes are back-filled with suitable material and thoroughly tamped in layers. After back-filling, the posts shall be sawed to exact grade and sloped or beveled as called for on the plans. Posts and railings shall be so shaped or notched that satisfactory contact surfaces will be obtained where rails are secured to the posts. All rails shall be squarely butt-jointed at posts.

Unless otherwise specified, sawed and surfaced guard rail shall be painted above a point 8 inches above the ground with three coats of approved white paint as hereinbefore specified in Article 34.6.

If the construction involves the use of a laminated wood type of rail, the first and second coats of white paint shall be applied to the posts and to all surfaces of each member of the laminated rail prior to assembly.

The specifications for materials, erection and painting for the wood guard rail posts shall also apply to guide posts.

51.4 Method of Measurement and Basis of Payment. Wood guard rail shall be paid for at the price bid per linear foot of wood guard rail complete in place, measured from outside to outside of end posts; the price bid shall be full payment for all posts and rails; all materials, including nails, bolts, driftbolts, paint; all excavation and backfilling; all equipment, tools, labor, and incidentals.

Wood guide posts shall be paid for at the unit price bid per post complete in place; which price shall be full payment for all materials, equipment, tools, and labor and for the performance of all work necessary or incidental to the proper completion of the item, including all excavation, backfilling, painting and erection.

SECTION 52.

WIRE CABLE GUARD RAIL.

52.1 Description. Wire cable guard rail shall consist of wire cable and necessary fittings supported by wood posts, erected as may be indicated or directed and in accordance with the plans and specifications.

52.2 Materials. (a) ***Cable.*** The cable shall be manufactured of durable galvanized annealed steel having the properties as hereinafter specified.

The cable shall be composed of three (3) strands, each strand having seven (7) wires. The diameter of the finished cable shall not be less than three-quarters (¾) inch. The wires composing the cable shall be of such quality that the finished cable shall satisfy all the requirements hereinafter set forth. All the wires in the cable shall be of the same grade of steel and shall have approximately the same ultimate strength.

The lay of the finished cable shall not be more than seven and one-half (7½) inches. The lay of the wires in the strand shall not be more than four and one-half (4½) inches.

The diameter of the finished wires entering into the cable shall not be less than .117 inches and not more than .124 inches.

The minimum tensile strength of the cable shall be 13,000 pounds.

The wire shall be cylindrical in form and be free from scales, inequalities, flaws and splits.

Each wire from the cable shall be galvanized by the Hot Dip Method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to the surface of the wire, and it shall be capable of withstanding four (4) immersions in a standard testing solution of copper sulphate without showing any trace of metallic copper on the steel. The first three (3) immersions shall be for a period of one minute each and the fourth (4th) immersion for a period of one-half minutes.

All wire cable must be shipped upon substantial wooden reels. Each reel shall have the length and weight of the cable plainly and indelibly marked on a strong tag, firmly attached.

The wooden reel shall be mounted so that it will revolve, and the cable run off by pulling straight ahead.

(b) ***Fittings.*** Turnbuckles shall be drop forged steel.

Eyebolts shall be welded or drop forged.

All metal fittings including threads shall be galvanized after forming in accordance with the requirements for galvanized wire cable.

(c) *Posts.* The posts shall be 8" x 8" sawn posts or round posts of Douglas Fir, Lodgepole Pine, Ponderosa Pine, Northern White Cedar, Western Red Cedar, Larch, or Tamarack. Round posts shall have a diameter of not less than eight (8) inches nor more than nine (9) inches at the small end and shall be straight, sound, free from defects of all kinds, and shall be peeled, shaved, and thoroughly seasoned and dry when treated. They shall have been cut from live, green, growing timber not less than 30 days in advance of treatment. Sawn posts shall be equal to the grade defined as select common in accordance with American Lumber Standards for soft wood lumber. All posts shall receive an eight (8) pound empty-cell creosote pressure treatment in accordance with the provisions for the preservative treatment of timber structures as hereinbefore contained in Article 34.3.

52.3 Construction Methods. The posts shall be set and tamped in a plumb and firm position to the depth, line and spacing shown on the plans or directed by the Engineer. Fittings shall be installed as shown on the plans and the wire shall be tightened just enough to take up all the sag between the posts, the exact amount depending upon the temperature at which the fence is erected, and making the allowance for the effect of change in temperature on the length of cable.

52.4 Method of Measurement and Basis of Payment. This item will be paid for at the unit price bid per linear foot of wire cable guard rail complete in place, measured from outside to outside of end posts; the price bid shall be full payment for all posts and cable, all materials, including anchors and all fittings, all excavation and back filling, all equipment, tools, labor and incidentals.

SECTION 53.

LEAD PAINTS, TARS & CREOSOTES.

53.1 Description. Steel and timber structures shall be painted as hereinbefore specified for the various items of construction or as shown on the plans.

53.2 Materials. The grade and quality of the paint for the various coats specified shall conform to the following requirements:

A. Pigments and Vehicles.

Ingredients used in the manufacture of paints shall conform to the following requirements:

1. Red Lead. D83-31 American Society for Testing Materials.
2. Basic Sulphate White Lead. D82-24 American Society for Testing Materials.
3. Basic Carbonate White Lead. D81-34 American Society for Testing Materials.
4. Lampblack. D209-30 American Society for Testing Materials.
5. Zinc Oxide. D79-24 American Society for Testing Materials.
6. Raw Linseed Oil. D234-28 American Society for Testing Materials.
7. Japan Drier. Standard Specification No. 20 of the Federal Specifications Board.
8. Turpentine. D13-34 American Society for Testing Materials.

NOTE: Turpentine and drier shall be added to paint in the field only as paint is used in order to insure the same paint consistency for each coat. Approved measuring and mixing devices are to be provided. In cold weather, if paint is too viscous to spread readily, it must be heated in a manner that will not injure the paint ingredients nor allow moisture or other material to combine with the paint.

9. Asphalt for use in damp-proofing and water-proofing below ground level. D40-25 American Society for Testing Materials.

10. Asphalt for use in damp-proofing and water-proofing above ground level. D144-25 American Society for Testing Materials.

11. Primer for use with asphalt in damp-proofing and water-proofing below and above ground level. D41-26 American Society for Testing Materials.

B. Paints for Metals.

Shop Coat:
35 pounds red lead paste (7% raw linseed oil by weight).
1 gallon raw linseed oil (weight 7.75 pounds).
¼ pint turpentine (weight .23 pounds).
¼ pint Japan drier (weight .30 pounds).

First Field Coat: Gray.
25 pounds basic carbonate white lead paste (9% raw linseed oil by weight).
⅞ gallon raw linseed oil (weight 6.78 pounds).
½ ounce lampblack (dry pigment or its equivalent in paste).
¼ pint turpentine (weight .23 pounds).
¼ pint Japan drier (weight .30 pounds).

Second Field Coat: Gray.
25 pounds basic carbonate white lead paste (9% raw linseed oil by weight).
⅞ gallon raw linseed oil (weight 6.78 pounds).
2 ounces lampblack (dry pigment or its equivalent in paste).
¼ pint turpentine (weight .23 pounds).
¼ pint Japan drier (weight .30 pounds).

C. Paints for Woods.

First Coat (Priming):
100 pounds basic carbonate or basic sulphate white lead paste (9% raw linseed oil by weight).
5 gallons of raw linseed oil.
2 gallons of turpentine.
1 pint of Japan drier.

Second Coat (Body):
100 pounds basic carbonate or basic sulphate white lead paste (9% raw linseed oil by weight).
2½ gallons of raw linseed oil.
1½ gallons of turpentine.
1 pint of Japan drier.

Third Coat (Finish):
60 pounds basic carbonate or basic sulphate white lead paste (9% raw linseed oil by weight).
40 pounds zinc oxide paste (14% to 20% raw linseed oil by weight).
3 to 4 gallons of raw linseed oil.
1 pint of turpentine.
1 pint of Japan drier.

A variation of 5% either way from the quantities of pigments shown in the foregoing formulae will be allowed. The amount of linseed oil and drier added will be varied to suit local conditions, except in ready mixed paints only turpentine may be added with the consent, or at the discretion of, the Engineer.

Black Paint (For Guard Rail Posts):
20 pounds of lampblack paste containing not more than 75% raw linseed oil.
4½ gallons of raw linseed oil.
2 quarts of turpentine.
1 pint of Japan drier.

D. Tars and Creosotes.

Tars and creosotes shall conform to the following requirements:

1. Tar for cold application. D 105-30 American Society for Testing Materials.
2. Tar for hot application. D 108-30 American Society for Testing Materials.
3. Creosote, primer coat, brush or dip method. D 43-25 American Society for Testing Materials.
4. Grade 1 and 2 creosote oil, and creosote coal-tar solution. American Wood-Preservers' Association.

E. Testing and Sampling.

All tests will be made in accordance with methods prescribed by the American Association of State Highway Officials or by the American Society for Testing Materials under their proper letter and serial designation.

Representative samples of paints or paint ingredients, tars, or creosote shall be furnished the Engineer by the Contractor for testing if required, and twenty-one days time will usually be required for the completion of tests.

In order to prevent the necessary delays in collecting and testing samples, the Contractor may furnish the Engineer with certified copies in duplicate of guaranteed formulae or chemical analysis from the manufacturer stating that the product which they propose to furnish to the Contractor for any particular job conforms to these specifications and to the formulae or analysis on the original containers. The guaranteed formulae or analysis must be a part of or attached to a sworn statement signed by a legal representative of the manufacturer. One copy of this the Engineer will forward to the Laboratory, which will either approve, reject or request that samples be furnished for testing.

Ready mixed paints, tars and creosotes shall be shipped in the original sealed containers of the manufacturers, and must have the true guaranteed formulae or chemical analysis of the contents plainly marked on the outside.

No Engineer or Inspector shall permit the use of any paints, tars, or creosotes until he has received from the laboratory an acceptable report on the certified copy of guaranteed formulae or chemical analysis as certified to by a legal representative of the manufacturer, or a report on samples previously submitted by him.

53.3 Method of Construction. Painting shall be done in strict accordance with the appropriate provisions of specifications hereinbefore set forth in the following Articles:

(a) Structural Steel: Shop Coat—Article 33.8.
Field Coats—Article 33.12.
(b) Treated Timber: Article 34.5 (b), (e), and (h).
(c) Untreated Timber: Article 34.6.

53.4 Basis of Payment. The work prescribed under this item shall not be paid for directly, but shall be considered as subsidiary work pertaining to the various items of work and no additional allowance will be made therefor.

SECTION 54.

ALUMINUM PAINTS.

54.1 Description. Aluminum paint conforming to the following specifications shall be used to paint steel and timber structures when specified in special provisions or noted on the plans. Unless so specified in special provisions or noted on the plans, it shall be understood that lead paints are to be used.

54.2 Materials. Aluminum paint shall have the following composition:

Paint for Metal and Untreated Wood.

Aluminum powder	2.00 lbs.
Varnish	1.00 gal.

Paint for Creosote Treated Wood.

Aluminum powder	2.25 lbs.
Varnish	1.00 gal.

Aluminum Powder. Aluminum powder shall meet the requirements as set forth in the specifications of the American Society for Testing Materials, Serial Designation D266-31 with subsequent revisions.

Varnish for Aluminum Paint on Metal. Varnish shall be designated as a long oil varnish and shall be of but one grade having the following properties:

(a) The varnish shall be clear and transparent.
(b) The varnish shall contain not less than 50 per cent, by weight of non-volatile oils and gums.
(c) For toughness the varnish shall pass a 60% Kauri reduction test at 24° C.

(d) The varnish shall "set to touch" in not less than 2 hours nor more than 6 hours, and shall "dry hard" in not more than 24 hours.

(e) The varnish shall be of such consistency that when mixed thoroughly with aluminum powder, conforming to the specifications, in the proportion of 2 pounds of powder per gallon of varnish, the paint shall show satisfactory spreading qualities and shall not run or sag when applied to a vertical surface.

Varnish for Aluminum Paint on Wood. Varnish shall be designated as "Kettle Bodied" linseed oil, containing the necessary amounts of thinner and drier.

The bodied oil vehicle shall contain not less than 60%, by weight, of non-volatile oil and driers.

The paint shall set to touch in not less than 6 nor more than 10 hours, and dry hard in not more than 30 hours.

Varnish for Aluminum Paint on Creosote Treated Wood. Vehicle or Varnish for Aluminum Paint on pressure creosote treated timber shall be a hard dry long oil, varnish type, containing 50% by weight of non-volatile oils and gum. The ratio of the oil to gum should be approximately three to one. (Some times referred to as forty gallon varnish). The major portion of the vehicle shall consist of heat treated China wood oil, and the remainder heat treated linseed oil. It shall set to touch in about two hours and dry hard in twelve hours.

Mixing. The powder shall be mixed with the varnish in sufficient quantities only for each day's use. The paint shall be thoroughly mixed by vigorous stirring, and afterwards frequently stirred to retain the proper consistency. Ready mixed aluminum paint shall not be used.

Sampling and Testing: Varnish. A thoroughly representative sample of the varnish proposed for use or as delivered shall be selected by the Inspector and forwarded to the Laboratory for tests as described in A. S. T. M. Serial Designations: D154-28, with subsequent amendments.

54.3 Construction Methods. Before applying any paint, the surface shall be thoroughly clean and dry and all loose paint or scale shall be removed. No exterior painting shall be done in wet or freezing weather, or under conditions otherwise, in the opinion of the engineer, unsatisfactory for work. Each coat of paint shall be allowed to dry for 48 hours before a succeeding coat is applied.

Aluminum Paint may be applied by either brushing or spraying. If spraying equipment is employed, the usual precautions shall be exercised.

In applying Aluminum paint with a brush, care shall be taken that all of the final strokes are made in the same direction in order that the particles of powder may "leaf" uniformly in the paint film. None but skilled painters are to be employed.

Painting Steel Outdoors—Old Work. After thorough cleaning to remove all loose scale or rust, all bare spots shall be painted with a primer as specified for new steel. One or two coats, as specified, of Aluminum Paint made with a long oil varnish vehicle shall be applied over the old paint.

Painting New Steel Outdoors. (a) The first field or primer coat shall be of the following composition:

28 lbs. red lead paste (7% raw linseed oil by weight).
1 gallon raw linseed oil (weight 7.75 pounds).
¼ pint turpentine (weight .23 pound).
¼ pint Japan drier (weight .30 pound).

This paint shall be tinted light brown by the addition of lampblack if necessary to distinguish from shop coat.

(b). One or two coats of Aluminum Paint, as specified, shall be applied over first or primer coat.

Painting Wood Outdoors. Wood surfaces which are to be painted shall be dry and free from dust or old loose paint before any paint is applied. The paint to be used on wood shall consist of Aluminum Powder mixed with kettle bodied linseed oil varnish, in the proportion before mentioned. Three coats shall be applied to new exterior work, and the composition of the paint shall be the same for all three coats, except in the case of open-grained lumber or badly weathered wood. In this case, the priming coat shall contain one and one-half pounds of Aluminum Powder per gallon of kettle bodied linseed oil vehicle. In the case of old work, two coats of Aluminum Paint shall be used in all cases of exterior exposure.

54.4 Basis of Payment. The work prescribed under this item shall not be paid for directly, but shall be considered as subsidiary work pertaining to the various items of work and no additional allowance will be made therefor.